358 - 1581
352 - 7788

OSE THERMO ELECTRIC

32400 Series
232 Series

TO OPEN PUSH CENTER RING UP 1/2" & SWING TO RIGHT

Setup & Check out Procedure for Thermo Electric Furnace Controller 32402-00

1. Check out P/S - Plug in the fixture.
   Set R4 so ~~P/S +12 to 5~~ (PIN 2 for +5 neg) reads 1.019 V
2. Check voltage across Z3 (IN 2980A) 16V ±10%

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https://archive.org/details/manualsplus_05357

Instruction Manual

Indicating Thermocouple Controller

Model 32402

We have taken steps to prevent damage to your controller should it accidentally be hooked up to the wrong power source. Refer to Section 2-0 Installation, Paragraph 2-4 Power Input.

Remove the protective case. The power selector switch (LOCATED ABOVE THE TRANSFORMER) has been set for 220 Vac operation. If you wish 115 Vac operation, throw this switch. If you wish 220 Vac operation, leave the switch alone and cut the power input jumper wire as per section 2-0.

Printed in USA

7206

SPARE PARTS

The following additional Spare Parts are recommended to be kept on hand if your plant has more than one 400 series controller in operation.

A. Indicating Deviation Meter
   For Models 32402-00, 01, 02 and 03 use (A4869-1 or -2)*
   For Models 32402-10 and 11 use (A4869-3 or -4)*

B. Resistor R8, 100 ohms, 5W (A5472-2)

C. Zener Diode 1N4001
   For Models 32402-02,03 and 11 use (A5005)

D. Power Transformer and Switch Assembly (A6236)

E. Potentiometer 2200 ohms
   For Models 32402-02, 03 and 11 use (A5554)

F. Potentiometer 100 ohms-Dual Ganged
   For Models 32402-01 and -02 use (A4762)

G. Power Supply Board Assembly
   For Models 32402-00, 03, 10 and 11 use (A4292)
   For Models 32402-01 and 02 use (A5694)

H. Amplifier Circuit Board Assembly
   For Model 32402-00 and 01 use (A4894)
   For Models 32402-02, 03 and 11 use (A5570)
   For Model 32402-10 use (A5550)

I. Range Card and Measuring Circuit Board Assembly
   For Models 32402-00, 03, 10 and 11 use (A5544)
   For Models 32402-01 and 02 use (A5564)

J. Hi-Lo Alarm Circuit Board Assembly
   For Models 32402-02, -03 and 11 use (A5512-1)

*-1 for Fahrenheit scale
-2 for Centigrade scale
-3 for High Gain Model with Fahrenheit scale
-4 for High Gain Model with Centigrade scale

Thermo Electric part numbers appear in parentheses.

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Photographs and Parts Identification

Front View, Analog Setpoint
Front View, Digital Setpoint
Rear View
Inside View

Drawings

Power Supply Printed Circuit Board Assembly (A4892)

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	Range Card and Measuring Circuit Printed Circuit Board Assemblies (A5544 Analog and A5564 Digital)
	Scope Patterns
	Schematic Diagram 32402-00
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7-1	Variations on Construction
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B.	Instructions for Models with High and Gain (short span)
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	SD32402-03
	SD32402-10
	SD32402-11

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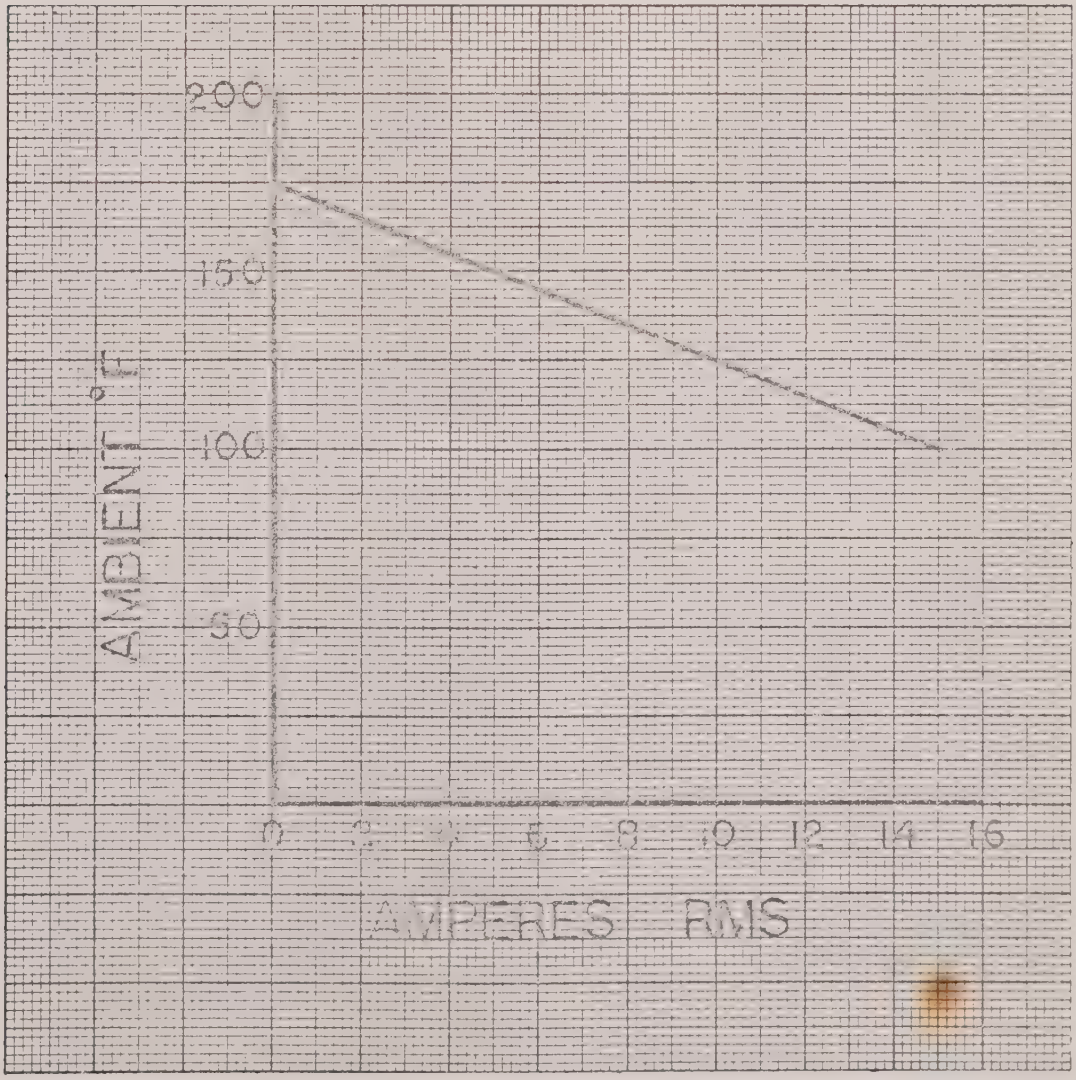
The following manual is applicable to standard instruments that will control processes requiring up to 15 amperes of power with a self-contained bidirectional triode Thyristor (TRIAC).

The TRIAC incorporated into Thermo Electric's 400 Series Controllers is rated at 15 amperes at 100°F ambient and a peak forward blocking voltage of 400 volts maximum, when the device is in a nonconducting state.

The chart below depicts typical values of conduction current versus ambient operating temperatures.



SECTION 1-0

INTRODUCTION AND DESCRIPTION

1-1 Introduction

This manual contains all the information normally required to operate and maintain the Model 32402 Indicating Thermocouple Controller. Should you require additional information, contact your local Thermo Electric Applications Engineer or our main office in Saddle Brook, New Jersey. We will be happy to be of assistance.

1-2 Application

This manual covers the operation, installation and maintenance of standard models as described in Thermo Electric catalog section 1p. For variations on construction refer to the Addendum.

1-3 Description

The Indicating Thermocouple Controller is a highly stable and accurate solid state instrument that provides automatic temperature control of a single electrically heated process. The controller measures the millivolt output of a thermocouple positioned in the process and controls power output with a Triac to maintain process temperature. The temperature control level is determined by the operator who adjusts the setpoint thumbwheel or knob on the front panel.

Process temperatures within 50°F (25°C) of setpoint are continuously read out on an indicating deviation meter above the setpoint scale. The meter is calibrated directly in degrees Fahrenheit (or Celsius). To prevent overshoot and cycling at setpoint, the controller provides proportional power output over a span or band which extends above and below the setpoint. The width of this proportional band is adjustable. The proportional band adjustment is mounted on the front panel.

Power output from start-up until process temperature reaches the proportional band is continuous, providing fast warm-up time. When process temperature enters the proportional band, power is supplied to the process in ON-OFF pulses. ON time pulses are of uniform duration and are emitted at the rate of several per second. To effect proportional action, the intervals (OFF time) between the power pulses are varied automatically by the proportional circuitry. OFF time pulses become longer as process temperature is approached, the duration of each OFF pulse being proportional to the difference between the setpoint level and process temperature. When process temperature equals setpoint level, an optimum ratio of ON to OFF pulses is achieved providing a precise balance between process power input and process heat losses. A reset control is mounted on the front panel to correct for process load changes. A red signalling lamp above the indicating meter on the front controller panel illuminates when power is being applied to the process.

To protect your process, failsafe circuitry cuts power to the process load if the thermocouple circuit opens. The process is protected against overloads with a 15 ampere fuse. (An I^2t, short circuit, fuse option is also available.)

Specifications

Measuring Circuitry

Setpoint Accuracy: ±0.25% of full scale span for analog setpoint; better than ±0.5% for digital setpoint.
Repeatability: 0.1% of full scale span.
Scale: 16 millivolt minimum span (spans to 10 mV possible with some change in operating specifications), 80 millivolts maximum.
Measuring Circuit: Potentiometric, solid state throughout.
Reference Junction Compensation: Automatic (temperature sensitive resistor at input connector)
Standardization: Continuous (temperature compensated Zener diode constant voltage supply)
Temperature Indication: Temperature deviation meter ± 50°F (± 25°C)
Deviation Meter Accuracy: ± 2°F maximum.
External (Sensor) Resistance: 100 ohms maximum (up to 500 ohms possible with controller re-calibration).
Standard Input: Thermocouple (see instrument scale or data plate for calibration)

Limits for External Conditions

Ambient Temperature: 40 to 120°F (operation), 0 to 150°F (storage)
Input Voltage: Switch selectable. 115 Vac ± 10%, 50-60 Hz or 220 Vac ± 10% 50-60 Hz. For 220 Vac operation jumper wire across resistor R69 must be removed.
Common Mode Rejection with 200 ohm input unbalance, DC and AC 1×10^6 (120 db.), maximum.
Normal Mode Rejection at 50-60 Hz: 1×10^3 (60 db.)
Long Term Stability (under constant ambient temperature and constant input line voltage): ± 30 microvolts.

Output Characteristics

Output: Triac provides up to 15 amperes at input line voltage to resistive load.
Maximum Power Output: Approximately 95% of Load Rating.
Type of Output: Full wave On-Off proportional control with "Zero Crossing"."On" time is fixed and "Off" time is proportional to deviation from setpoint.
Proportional Bandwidth: Adjustable from 10° to 50° F (5° to 25°C) from front panel.
Reset: Manual (adjustable from front panel)

Physical Specifications

Case: Ventilated (perforated) sheet steel
Dimensions: 4 3/16" W x 6 1/2" H x 13" D. Add approximately 3" to case depth for input plug and wiring clearance.
Weight: Approximately 6 pounds
Mounting: Flush panel, shelf or table top. Mounts with two concealed screws behind controller front panel.

1-5 Principles of Operation

The basic elements of the Model 32402 solid state Controller are shown in Figure 1-1. In operation, the measuring circuit produces a dc error signal which is converted to 2500Hz ac in the modulator circuit, then amplified and reconverted to dc by the demodulator circuit. The signal at the emitter follower stage is used to operate the temperature indicating meter. Proportional band and manual reset functions are imposed on the output of the dc amplifier stage. The signal is then converted to current pulses, synchronized with the line voltage, and the triggering pulses formed for firing the Triac which controls power to the process load.

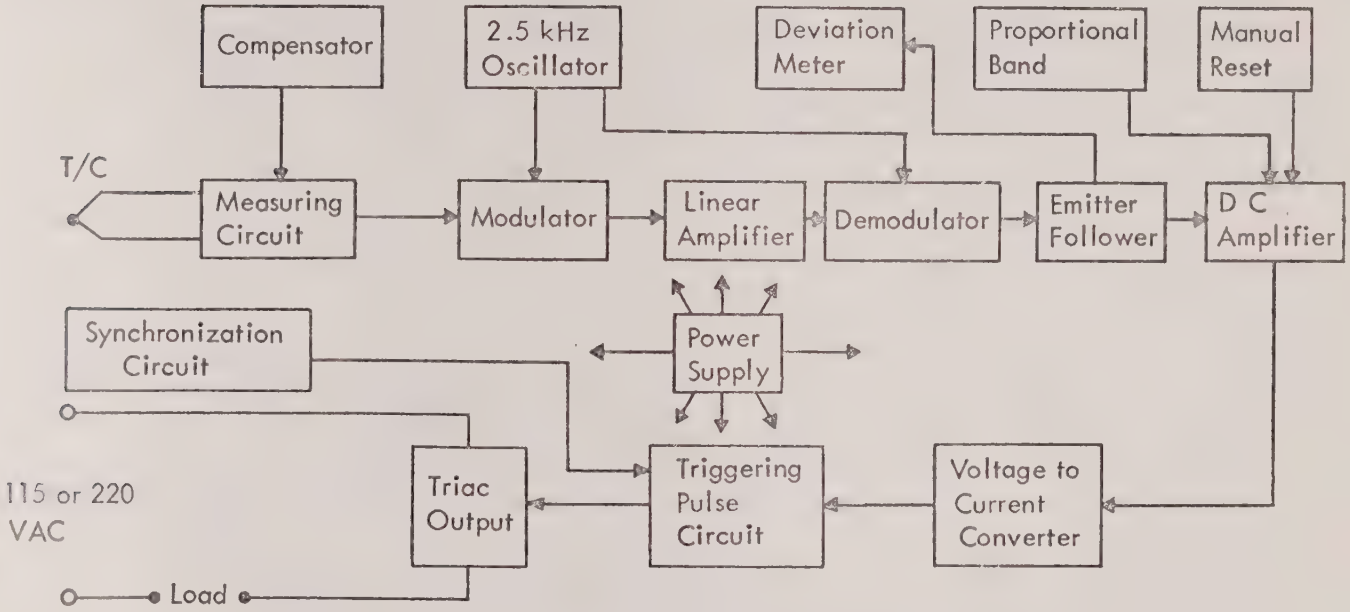


Figure 1-1. Controller Block Diagram

Power Transformer T1

The primary winding of the transformer (Figure 1-2) is capable of receiving either 115 Vac or 220 Vac, 50-60 Hz. Switch S2 (located on the transformer) provides a parallel arrangement of the windings for receiving 115 volts or a series arrangement for receiving 220 volts. Two secondary windings are provided; one for the amplifier power supply, and one for the measuring circuit power supply.

Measuring Circuit Power Supply

The measuring circuit power supply contains a half wave rectifier D2 and filter capacitor C2. The combination of the capacitor and the resistance of the secondary transformer winding provides the desired 50-60 Hz and harmonics filtration.

Regulation is accomplished by Zener diodes Z1 and Z2 in combination with resistors R62 and R61 respectively. Total regulation factor equals 1/8000.

Dropping resistor R65 and potentiometer R4 (used with analog setpoint only) reduce the voltage at Z2 to provide approximately 1.019 volts at 2 mA required by the measuring circuit. (See section 5-0 "CALIBRATION" for adjustment of R4). The measuring circuit power supply provides approximately 6.2 volts to the digital setpoint measuring circuit.

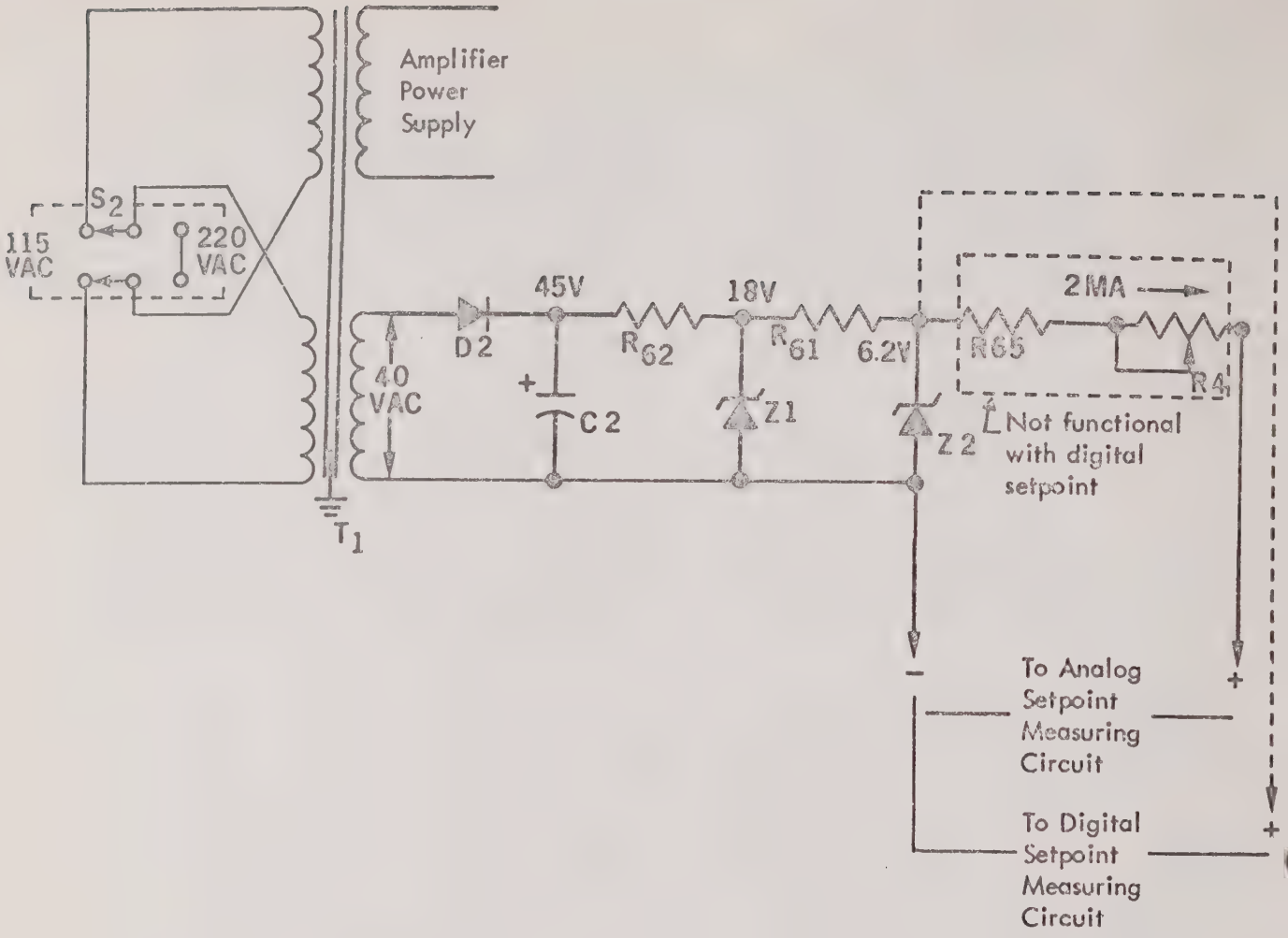


Figure 1-2. Measuring Circuit Power Supply

Measuring Circuit, Analog Setpoint

The measuring circuit power supply furnishes a current which causes a voltage differential between points A and B and between points C and E. The voltage picked off at point D adds to the thermocouple emf. This combined potential is opposed by the voltage picked off on the setpoint potentiometer (R66). The amplifier and control circuitry use the voltage difference (error signal) created by these opposing voltages to determine control functions.

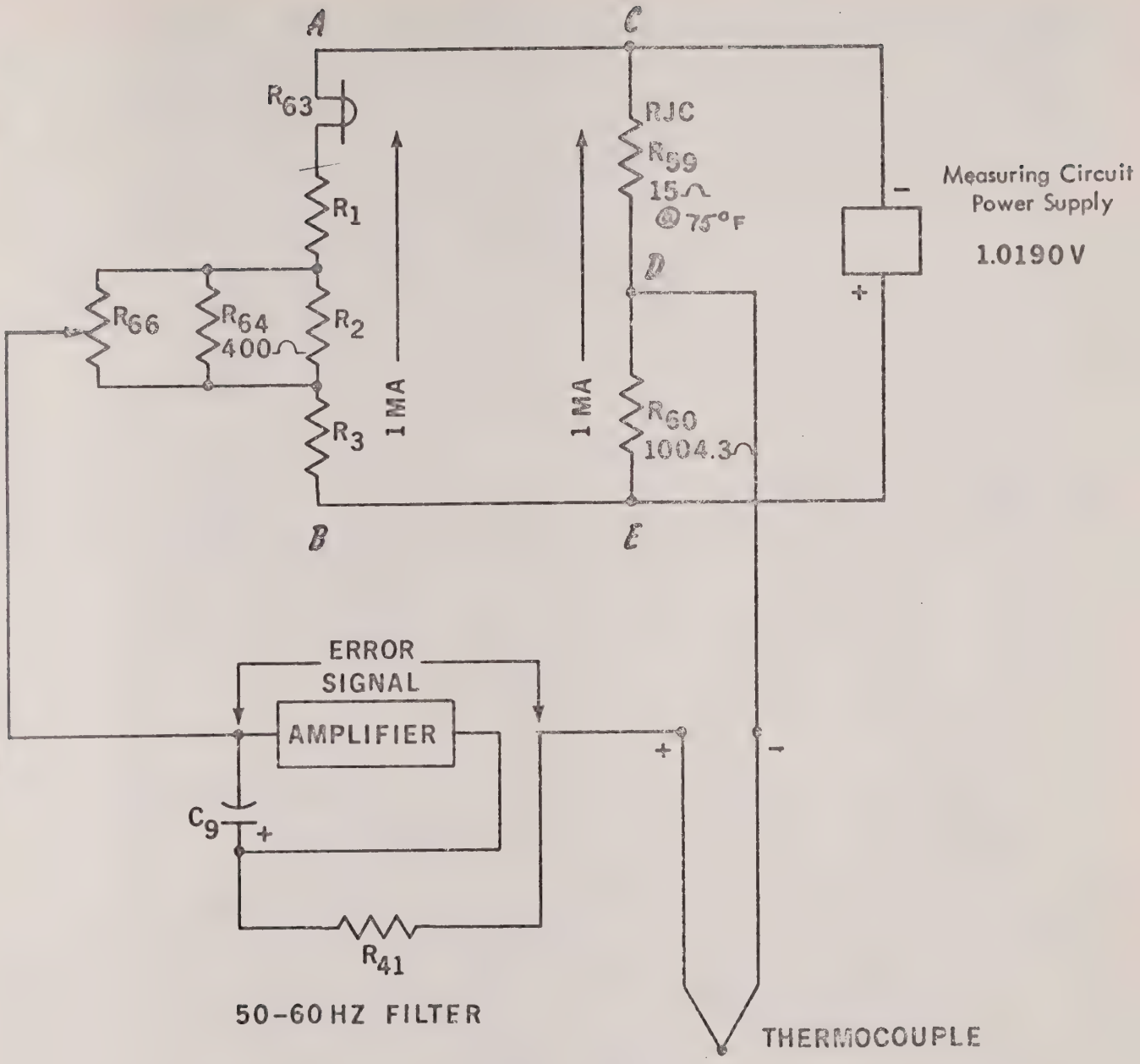


Figure 1-3. Potentiometer Measuring Circuit, Analog Setpoint

Measuring Circuit* Digital Setpoint

The measuring circuit power supply furnishes a current which causes a voltage differential between points A and B and between points C and E. The voltage picked off at point D adds to the thermocouple emf. This combined potential is opposed by the voltage picked off on the setpoint potentiometer (R68). Voltage "V" is set to obtain 1 mA of current through the setpoint circuit. The amplifier and control circuitry use the voltage difference (error signal) created by these opposing voltages to determine control functions.

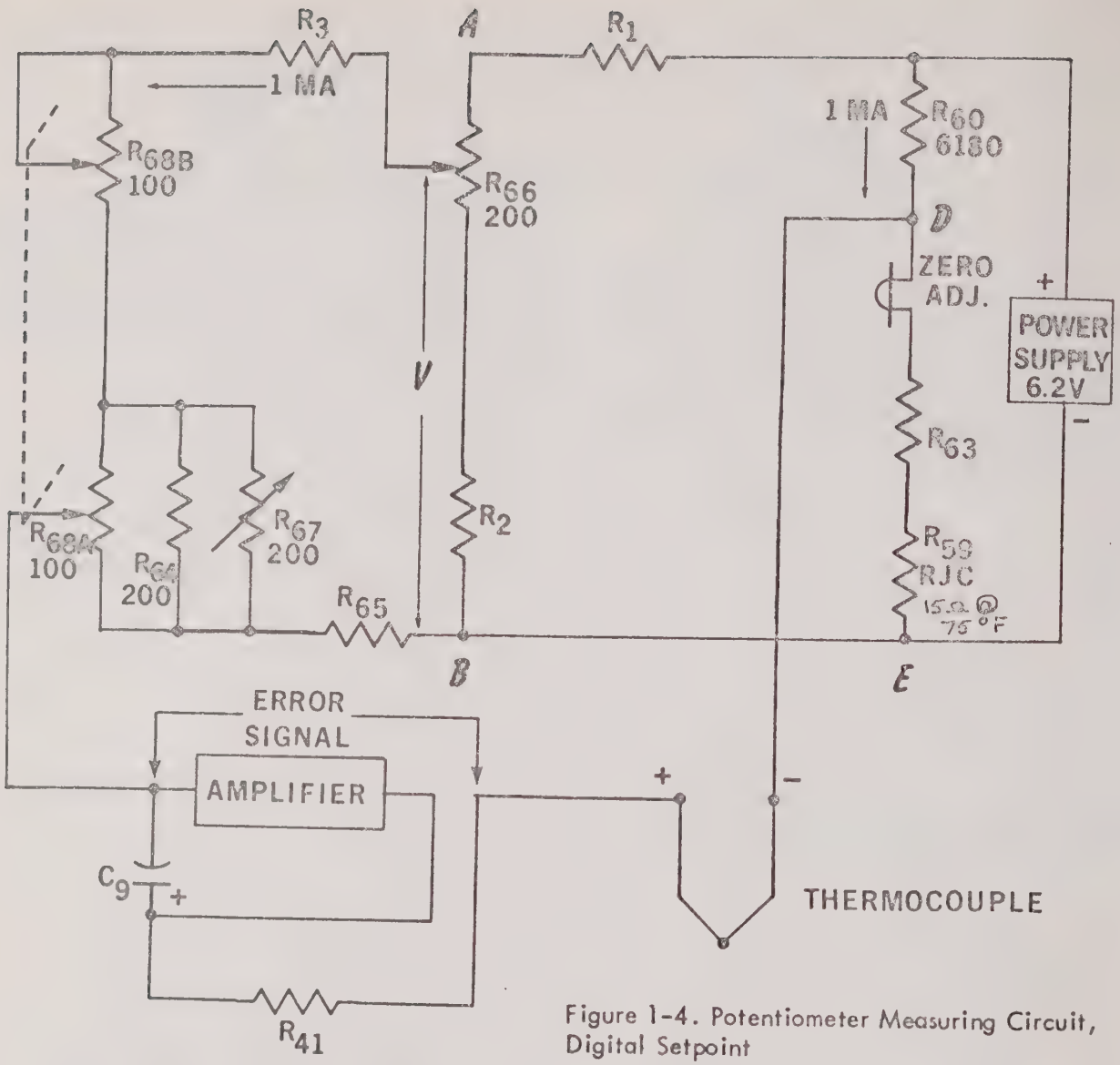


Figure 1-4. Potentiometer Measuring Circuit, Digital Setpoint

*Patent No. 3,472,073

Component Functions

1. RJC (Reference Junction Compensating Resistor)
Thermocouple reference junction compensation is obtained with RJC resistor R59. This component changes its resistance in proportion to reference junction temperature variations, and thus has a direct effect on the voltage picked off at point D in Figures 1-3 and 1-4. A rising reference junction temperature, for example, lowers the thermocouple emf. The temperature rise, however, also increases the resistance of the RJC, thus increasing the voltage at point D. Since the voltage at D adds to the thermocouple input, the RJC effectively compensates for the drop in thermocouple emf. In order to insure compensation for the correct reference junction temperature, the RJC resistor is mounted inside the thermocouple connector plug.

2. Resistors R1, R2, R3, R64 and R66 (Slidewire, analog setpoint) adjust the span across the slidewire so that the voltages picked off will match the millivolt range of the instrument. Resistors R3, R64, R65, R67 and R68 (digital setpoint potentiometer) adjust the span to match the digital dial to the millivolt range.

3. Resistors R1, and R2 and R66 in the digital setpoint controller adjust voltage "V" across the setpoint circuit. R66 also serves as a means of linearizing the millivolt range over the digital dial.

4. Zero adjust R63 (Resistor R63 and zero adjust for digital setpoint) provides a convenient method of zeroing the measuring circuit and correcting for small errors produced by resistance tolerances in the circuit. Compensation is provided for the operating level of the amplifier and assistance is also provided in placing the operating point of the amplifier in the midpoint of its linear range.

5. 50/60 Hz Filter

The input filter (R41 and C9) provides the instrument with a normal mode rejection ratio of 1×10^3 (see "SPECIFICATIONS").

Amplifier Power Supply

The DC Amplifier Power Supply contains a full wave bridge rectifier and filter capacitor C1. The combination of the capacitor and the resistance of the secondary transformer winding provides the desired ripple reduction.

Regulation is accomplished with Zener diode Z3 which provides 16 Vdc + 10%, -0% to the amplifier and pulse forming circuitry.

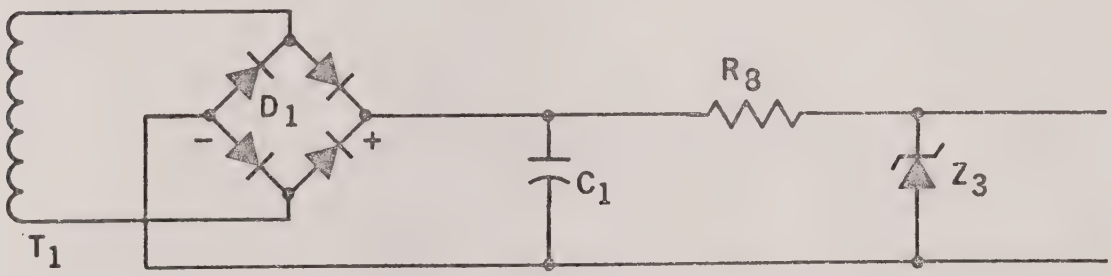


Figure 1-5. Amplifier Power Supply

Modulation

The error signal from the measuring circuit is chopped or converted to a 2.5kHz square wave for amplification, therby eliminating the performance difficulties inherent in dc amplification. Modulation is achieved by dual emitter transistor Q8. The transistor is driven by a 2.5kHz square wave oscillator consisting of transistors Q6 and Q7, several resistors and a capacitor, as shown in Figure 1-6.

Isolation between the oscillator and chopper is accomplished by interstage transformer T3. The error signal is passed for amplification during half of the oscillation cycle and blocked during the other half.

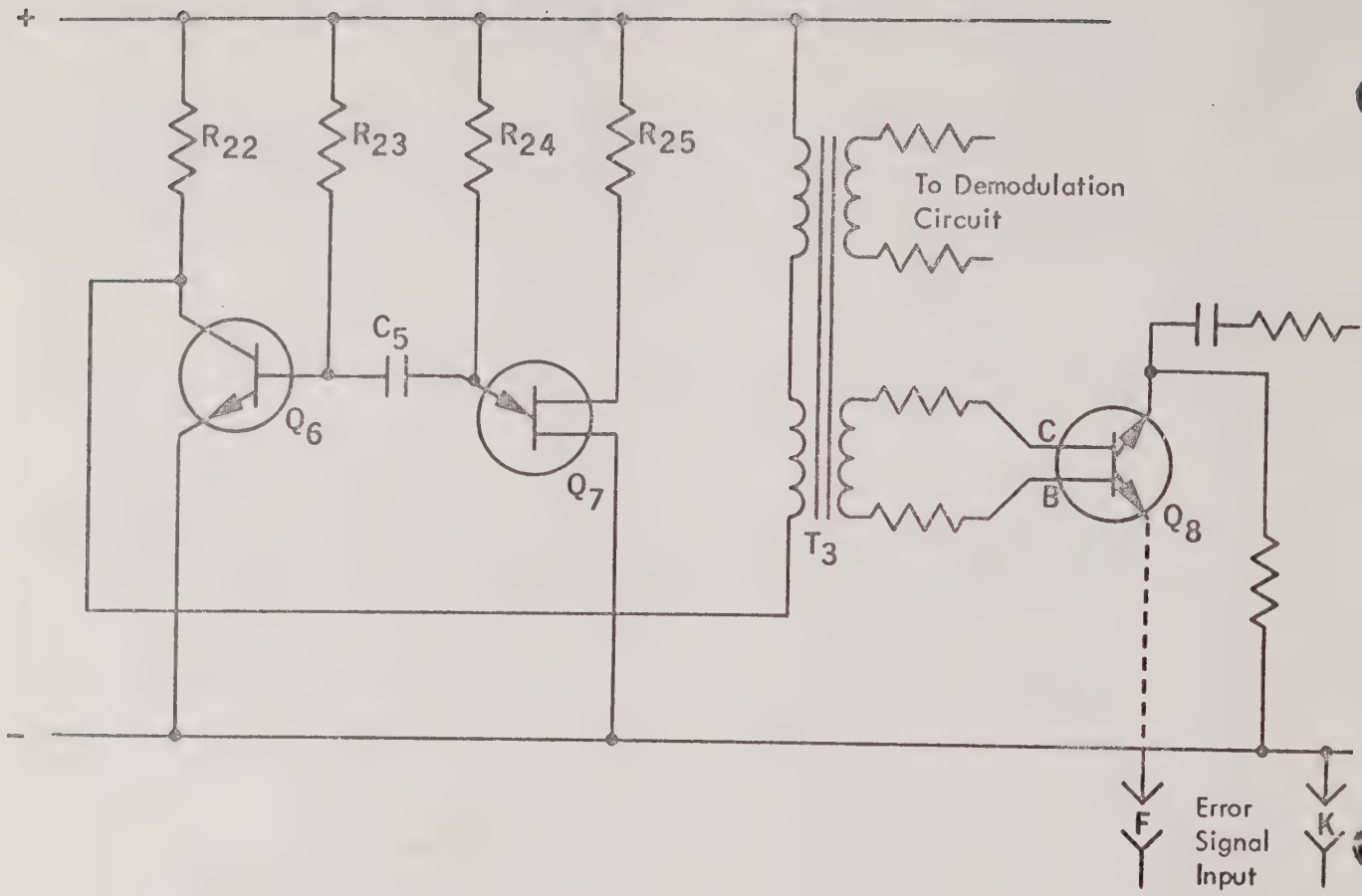


Figure 1-6. Modulator Circuit

AC Amplifier

This primary amplifying stage consists of Q9, Q10 and Q11. Feedback resistors are R42, R44, R48 and R33. All three transistors are biased for proper dc level and high stability. The power supply for Q9 is isolated from Q10 and Q11 by means of RC filter R30--C6. Power to Q10 is also isolated from the main supply by RC filter R31--C7.

Input impedance of the amplifier is about 2k ohms. The amplifier becomes saturated when the dc input signal is approximately + 2 millivolts. The ac wave form at the output of Q11 is about 10 volts in magnitude at saturation.

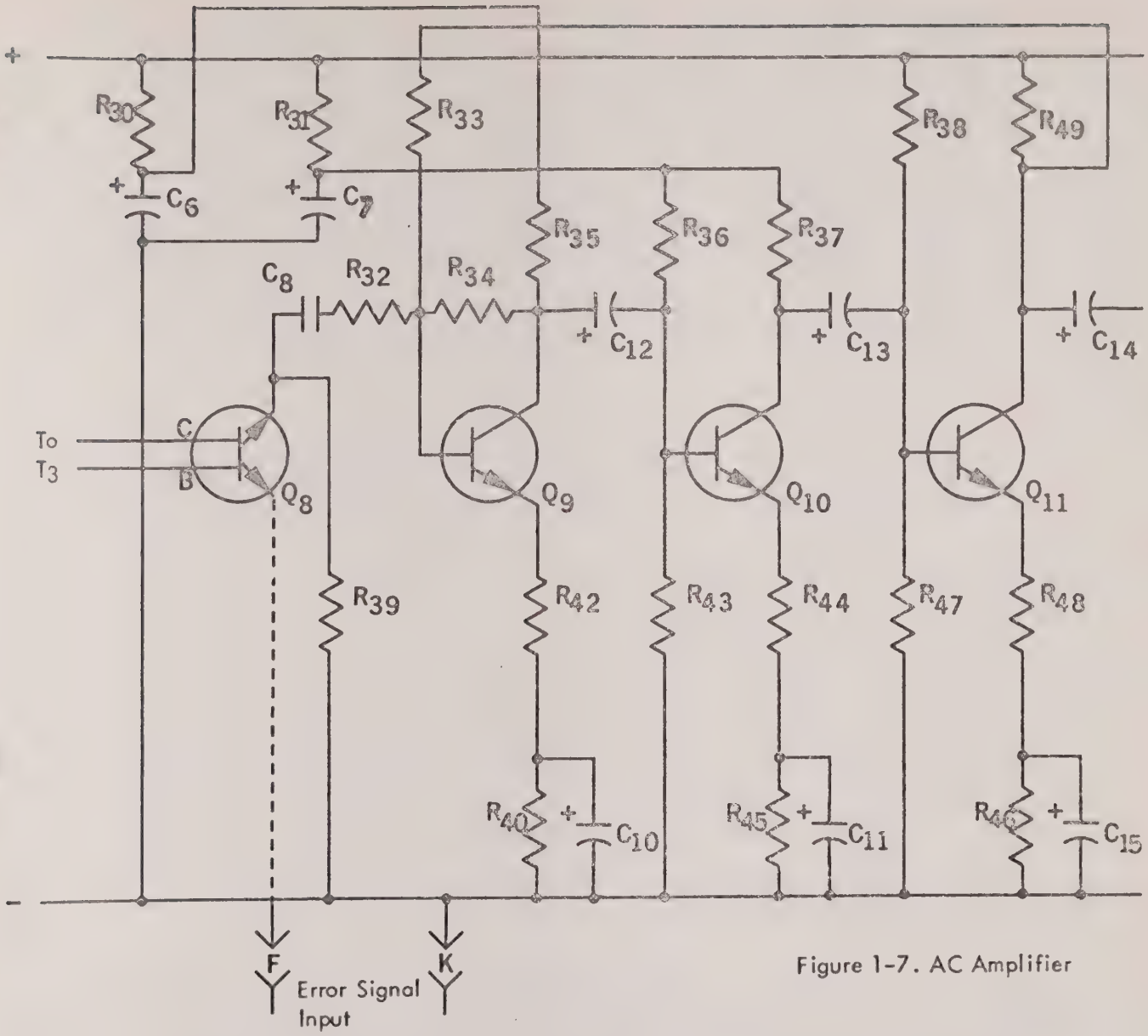


Figure 1-7. AC Amplifier

Demodulation

The signal from the collector of Q11 has a frequency of 2.5kHz and is almost 1000 times greater than the dc input signal. Since a dc signal is now required to drive the temperature deviation meter and perform the control functions, the amplified signal from Q11 is demodulated. This is achieved with transistorized chopper Q12.

Q12 is coupled electrically to the remaining secondary of transformer T3 to synchronize demodulation to input modulation. An RC filter consisting of resistor R50 and capacitor C16 rejects all high frequency components remaining on the dc signal after demodulation.

DC Amplifier

The dc output signal from the demodulator is connected to emitter follower Q13. Q13 in turn drives the deviation meter and Q14.

Deviation Meter

The meter indicates deviations of process temperature from the setpoint temperature setting. It has a zero center (null) position. With an assumed gain of 1,000, the dc amplifier output is linear with an applied amplifier input signal (measuring circuit error signal) of + 1.5 millivolts dc. This + 1.5 mV signal corresponds approximately to + 50°F for J calibration thermocouples and + 75°F for T or K thermocouples. The amplified signal output from Q13 is linear between 300 mV and 3 volts. To guarantee a swing of almost 1.5 volts in either direction, the 50-0-50 microamp deviation meter must balance when the output from Q13 is 1.5 volts. This is accomplished with the voltage divider (R7, R6 and R5) across the amplifier power supply. Potentiometer R21 is used for calibrating the meter for the precise span desired (± 50°F).

Proportional Band

Q14 is a common emitter dc amplifier. The proportional band rheostat (R55, Figure 1-11) is used to change the gain of this section. Figure 1-9 shows the effect of a wide and a narrow proportional band rheostat setting on the output voltage of Q14.

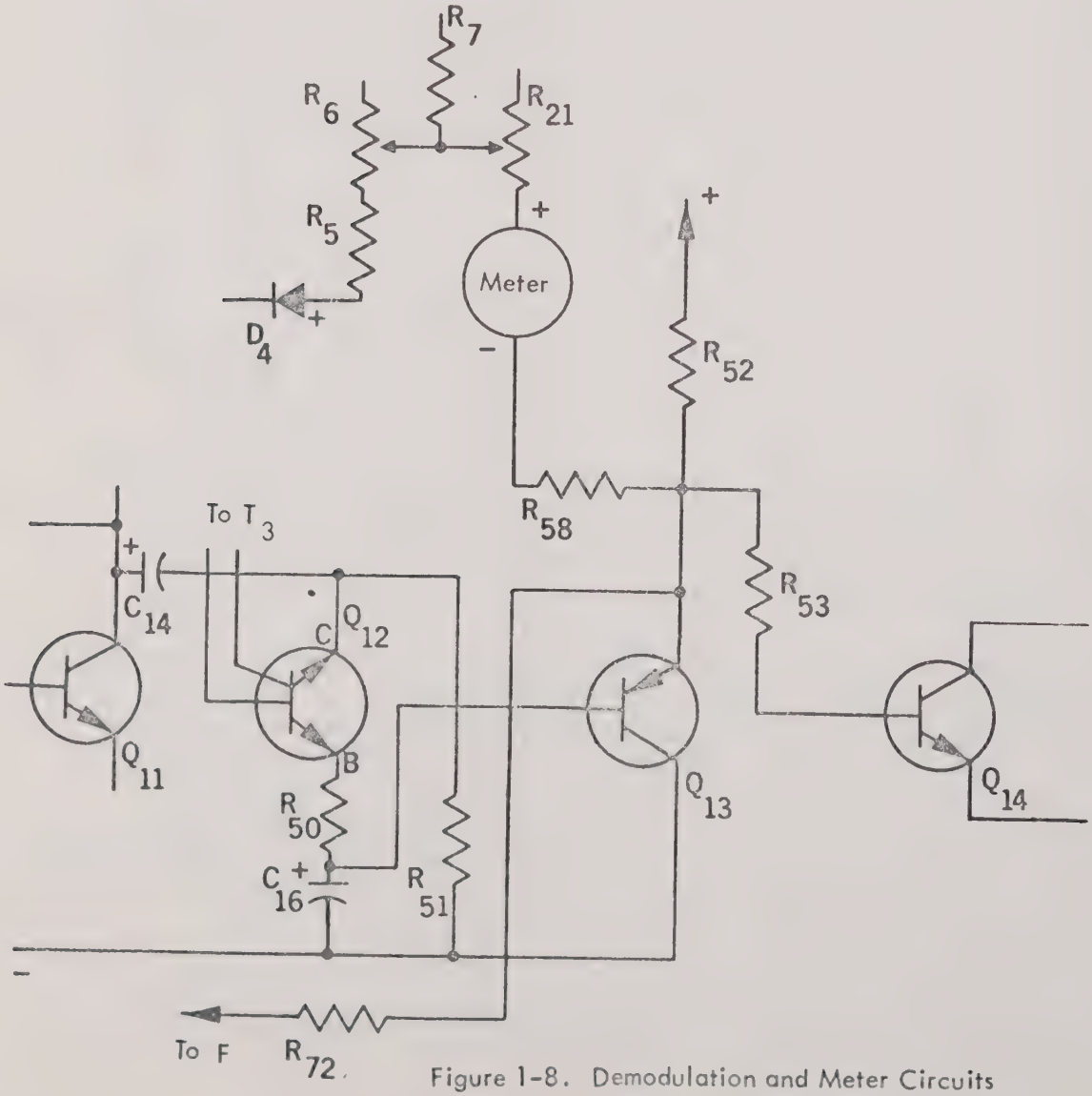
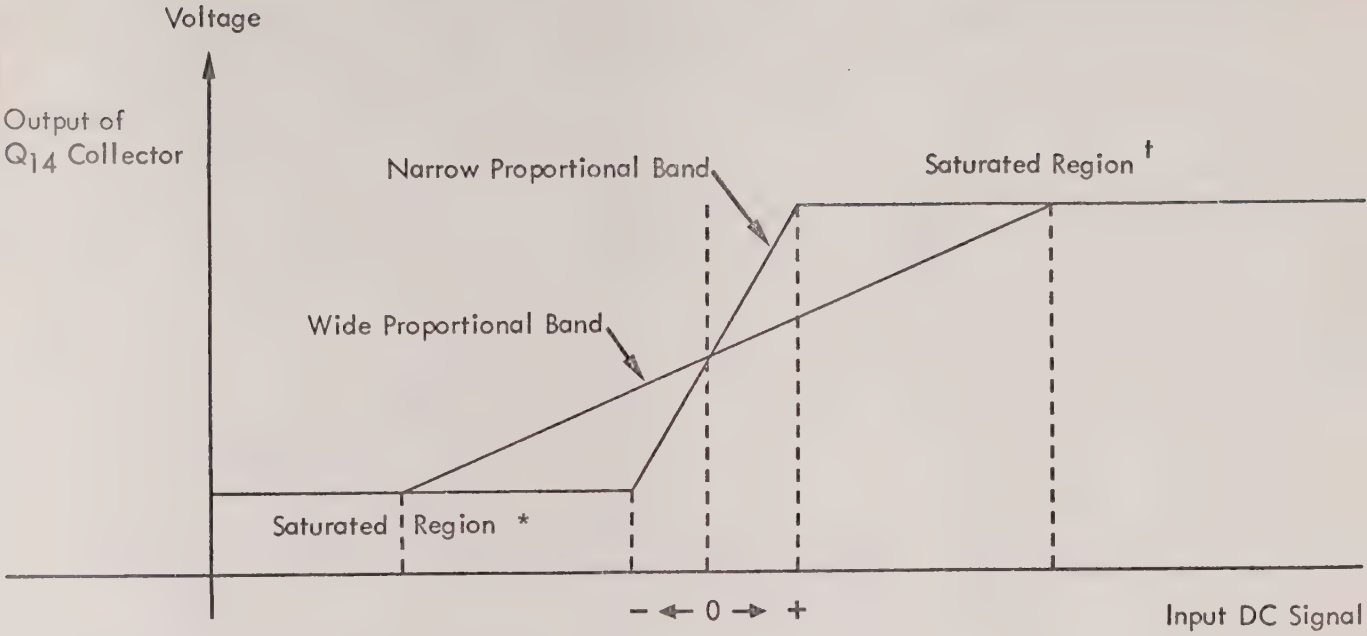


Figure 1-8. Demodulation and Meter Circuits



†Positive dc amplifier input (measuring circuit error signal) greater than 2mV

*Negative dc amplifier input greater than 2mV

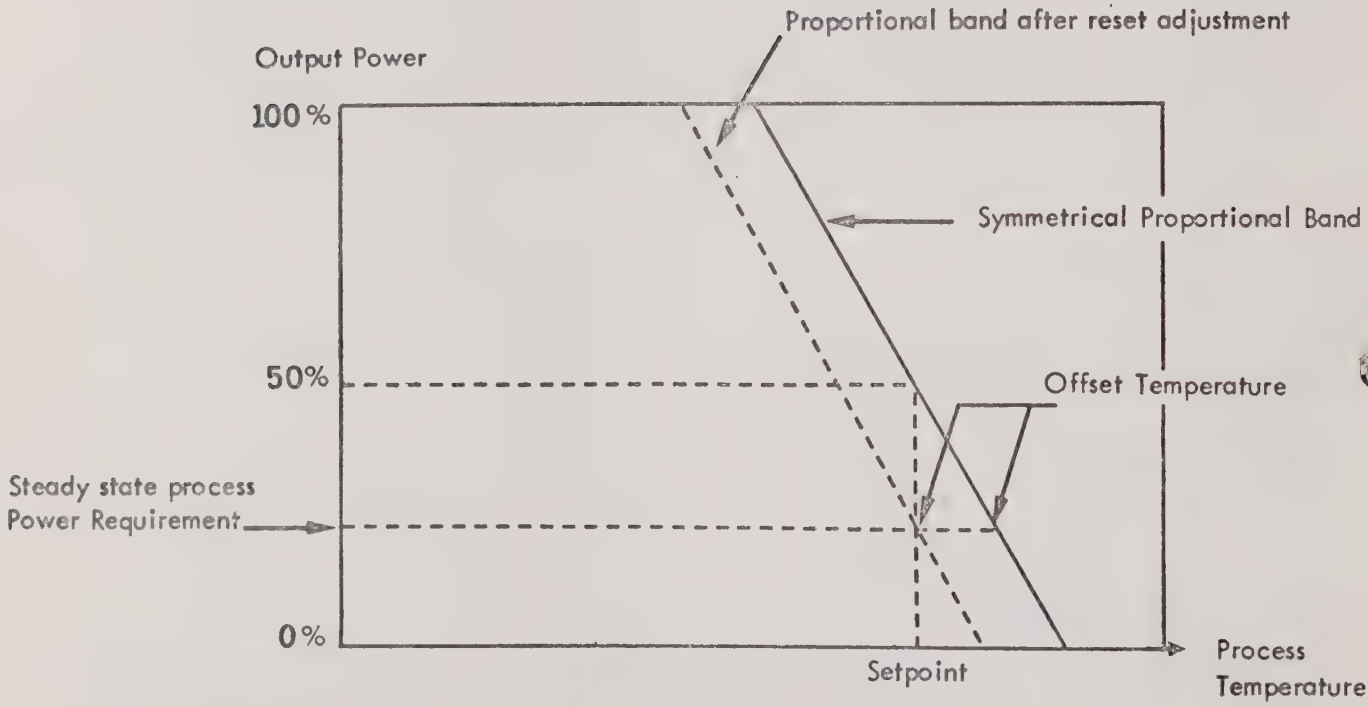
Figure 1-9. Proportional Band Setting Effect on Output of Q14

Manual Reset Action

Assuming that the output of Q14 has already been converted to power output and fed to a process load (Figure 1-10), it can be seen that the percentage of power supplied at setpoint will not maintain process temperature without an offset unless the percentage of output power coincides exactly with the process power requirements. Power output at setpoint is normally 50% of total power available in a symmetrical proportional band concept. This results in the process load being either under temperature or over temperature when the controller is at setpoint, unless the load requirement is exactly 50% of total power available. The manual reset control provided in the controller allows us to shift the proportional band, and thus the power available to the load at setpoint (Figure 1-10).

To achieve reset action, a dual concentric potentiometer (R56) is connected to the emitter of Q14. As can be seen in Figure 1-11, varying the resistance of R56 varies the operating level of Q14 without affecting its gain (proportional band). In operation, as the level of biasing of Q14 varies from its midpoint dc operating level, the proportional band is shifted so that it is no longer symmetrical with respect to the setpoint. This provides an effective method of eliminating offset temperatures.

It should be noted that adjustment of the reset potentiometer does not affect the span of the proportional band, but merely shifts the span up or down the setpoint temperature scale. This feature is important because the proportional band span should not be altered once it has been adjusted for optimum dynamic response of the system.



Feature 1-10. Ideal Effect of Reset Adjustment on Process Temperature Offset

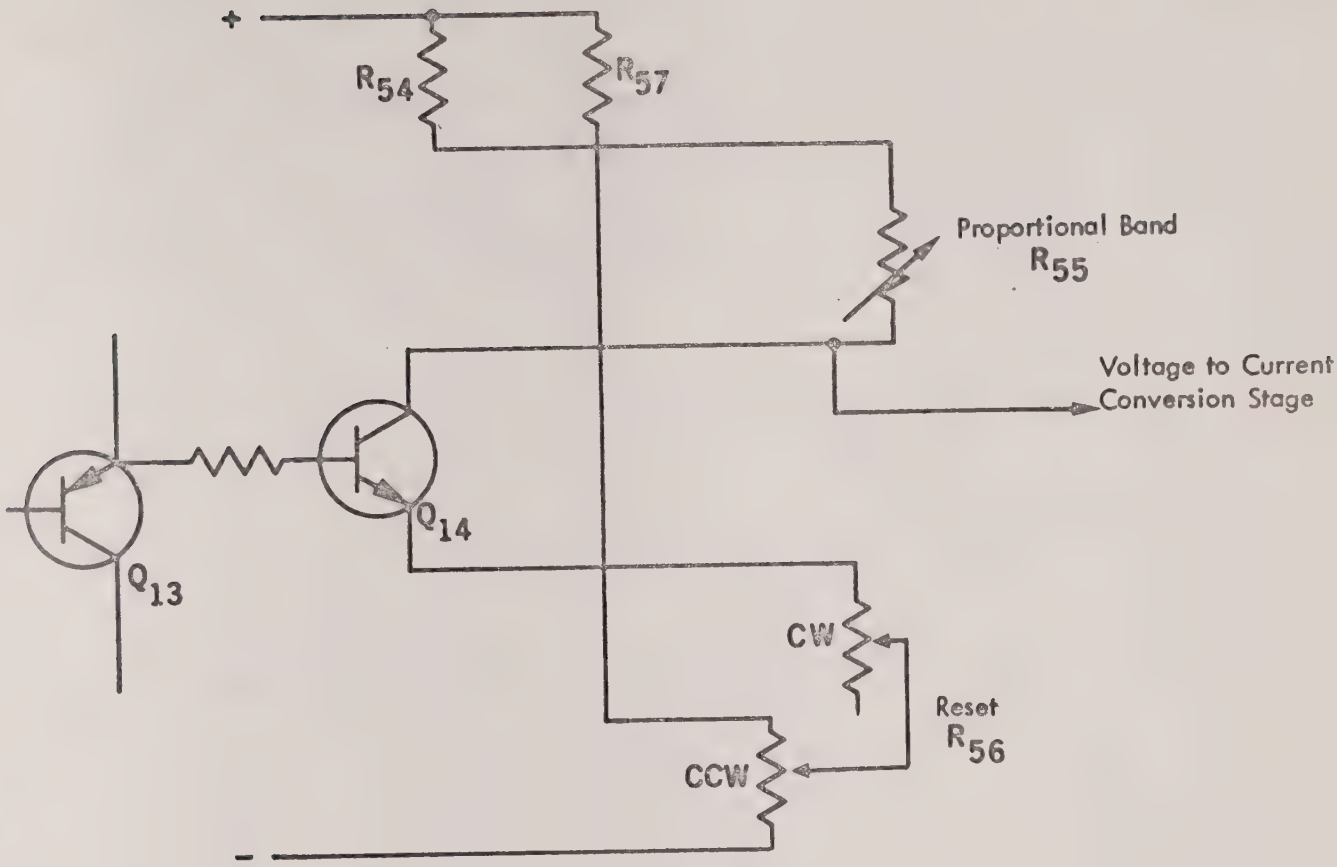


Figure 1-11. Proportional Band and Manual Reset Circuitry

Voltage to Current Conversion

The dc signal from the collector of Q14 is proportional to the dc error signal from the measuring circuit (providing the amplifier is not saturated). The output from Q14 is applied to the base of Q1 (Figure 1-12), which with the constant R10, regulates current flow to C4. This the time necessary to fully charge C4 is inversely proportional to the input to the amplifier, provided that the input (measuring circuit error signal) is positive.

Capacitor C5 delays the voltage input to Q1 so that rapid changes in setpoint or process temperature do not cause large voltages to immediately appear across the Triac.

Pulse Circuit

Automatic discharge of C3 is accomplished with the aid of unijunction transistor Q2 (Figure 1-12). When the potential at the emitter of Q2 with respect to the base reaches intrinsic standoff ratio (i.e. 0.47 to 0.62 for Q2), suddenly in the range of microseconds, emitter-base resistance approaches zero and capacitor C3 discharges through resistor R11. Thus, the voltage to current converter (Q1) and the above circuit produce pulses every "t" seconds (Figure 1-13), with "t" inversely proportional to a positive amplifier input.

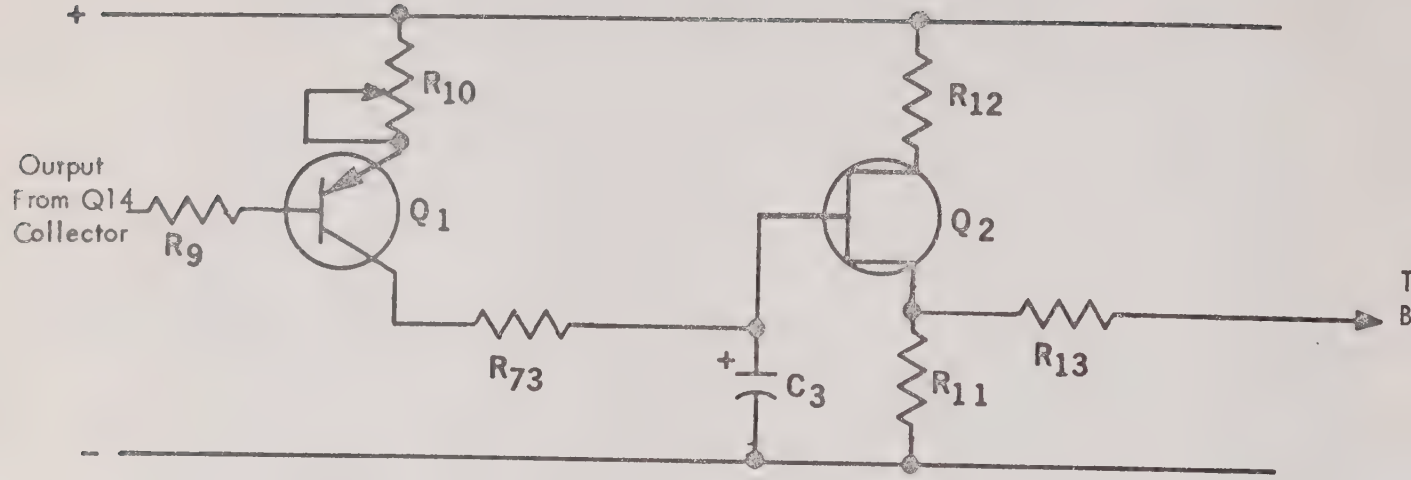


Figure 1-12. Voltage to Current Conversion and Pulse Circuit

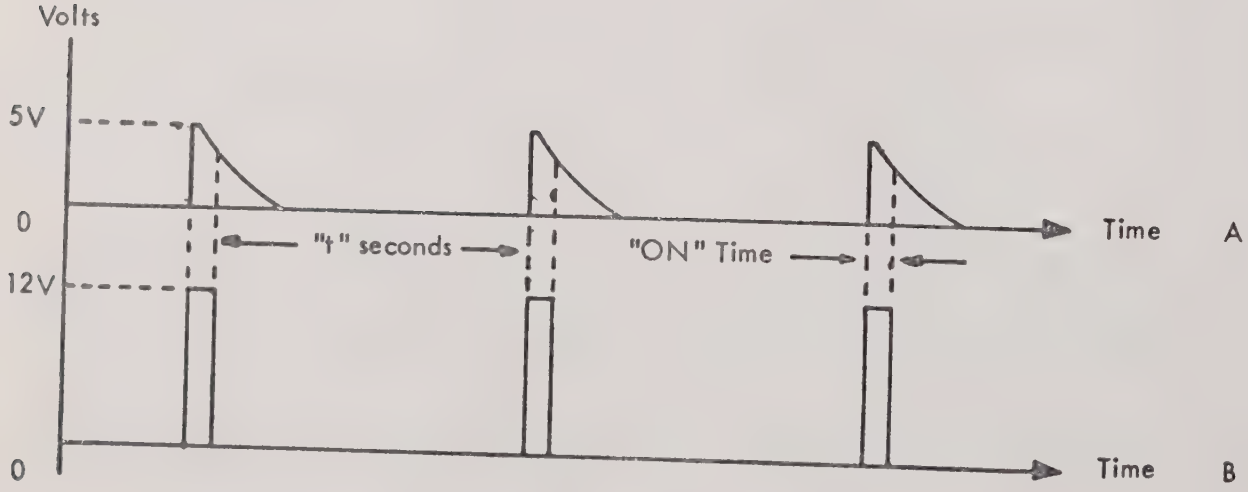


Figure 1-13. Input to Schmitt Trigger (A)
Output from Schmitt Trigger (B)

Schmitt Trigger-Figure 1-14

The Schmitt trigger is a regenerative circuit. When the input signal from the pulse circuit (Q2) crosses specific dc triggering levels, the Schmitt trigger abruptly changes state. This happens twice during each pulse from Q2, as shown in Figure 1-13. In effect, the Schmitt trigger acts as a switch to turn power "ON" when the voltage from a single pulse first crosses the triggering level, and turns power "OFF" as the same pulse voltage drops down below this level. It is important to note here that the total "ON" time of each pulse from the Schmitt trigger is constant regardless of minor variations in circuit parameters.

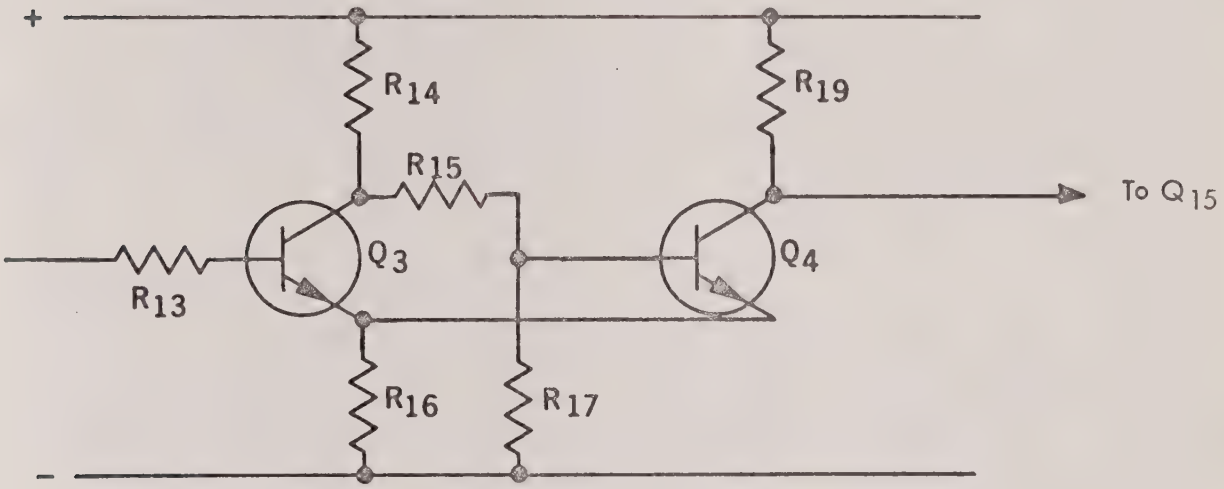


Figure 1-14. Schmitt Trigger

Synchronization Circuit - Figure 1-15

The purpose of the synchronization circuit is to eliminate the effects of radio frequency (RF) interference on other instrumentation located in the same area as the controller. This is accomplished by firing the Triac only when the line voltage is at zero volts. As shown in Figure 1-16, the voltage to the base of transistor Q15 is in phase with the input line voltage to the Triac and to transformer T1. As the voltage to the base of Q15 increases, the transistor becomes saturated and conducts the signal from the output of the Schmitt trigger (Q4). When the voltage to the base of Q15 returns to zero, Q15 acts like an open circuit and the triggering pulse from Q4 is passed on to Q5.

As can be concluded from the above description, the synchronization circuit is only of value when the voltage to the Triac is in phase with the line voltage. Transistor Q15 should be removed from the circuit in controllers with external power controllers unless the voltage to the power controller is in phase with the voltage to the indicating controller.

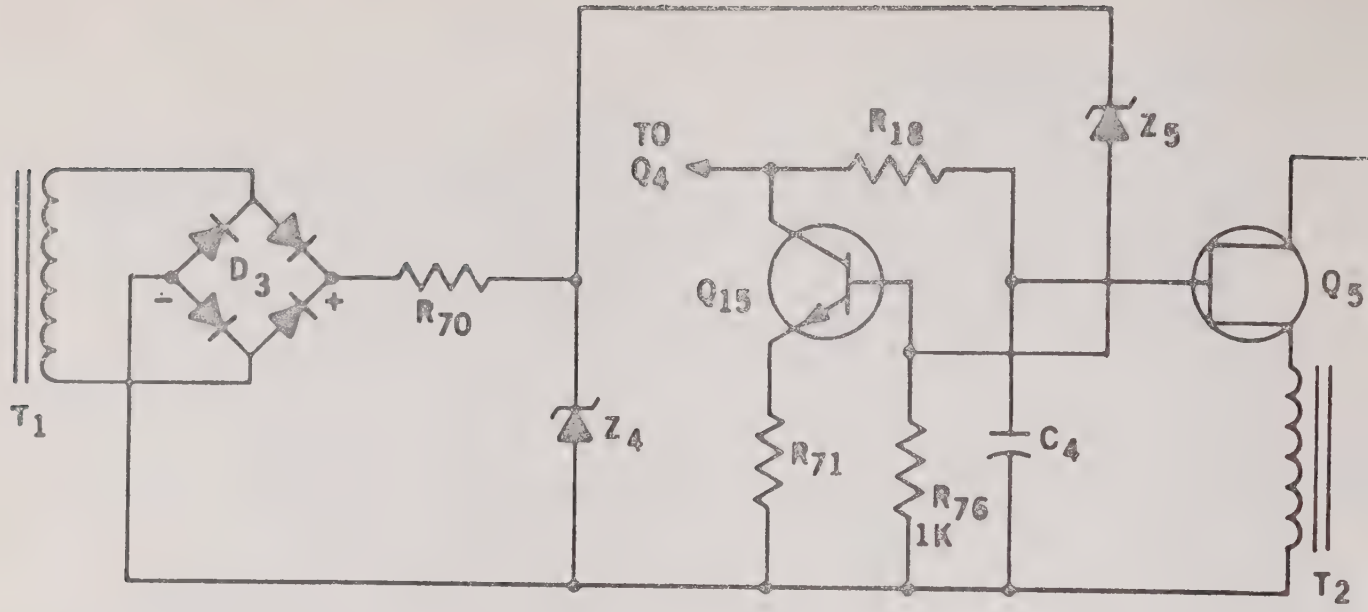


Figure 1-15 Synchronization Circuit

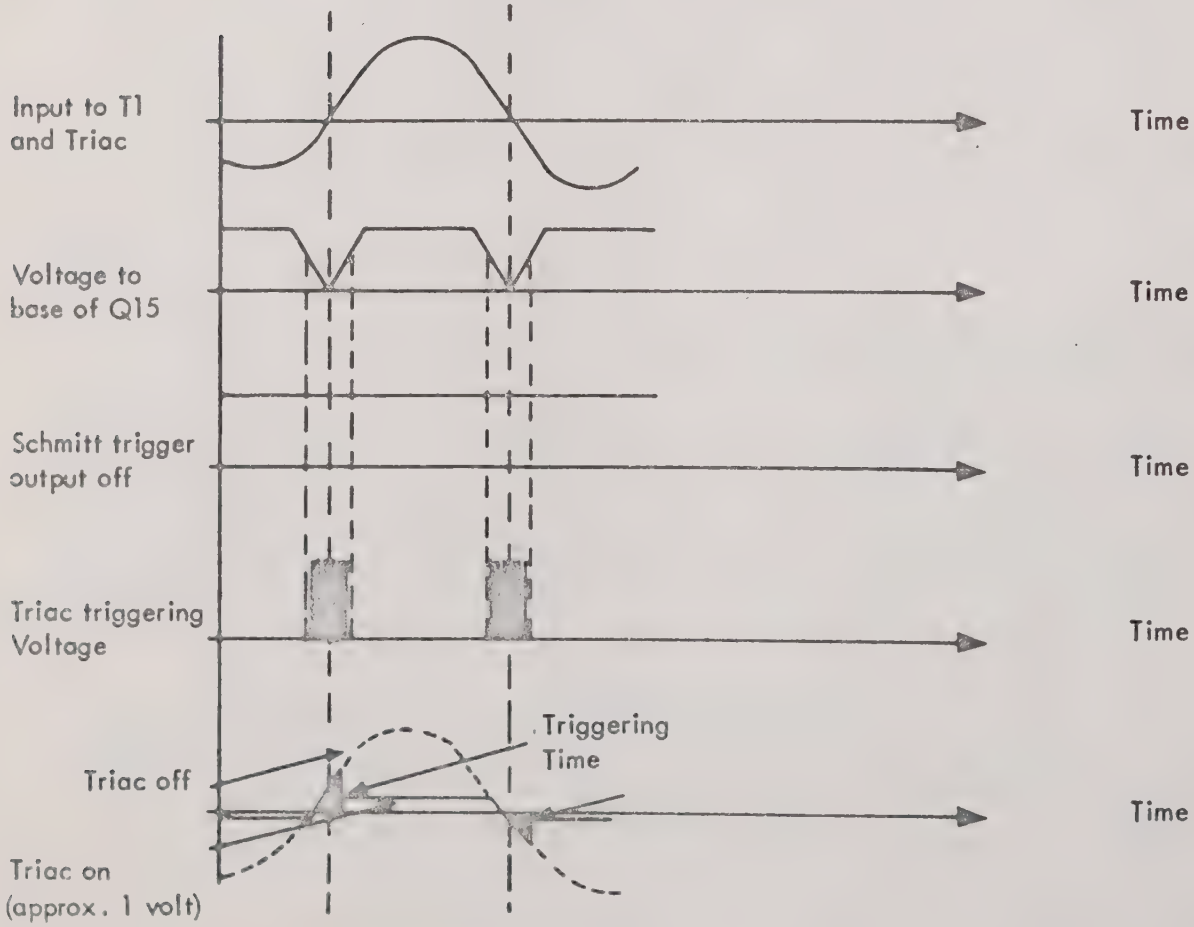


Figure 1-16. Synchronization Circuit Waveforms

Triac Triggering Circuit

The combination of R18, C4 and Q5 comprise the essential parts of a relaxation oscillator. The frequency of oscillation is about 1 KHz. Pulse Transformer T2 isolates the amplifier section from the power section. The circuit provides sufficient voltage to trigger any power SCR up to 50 amperes rating within an ambient temperature range of 32 to 120°F.

From the above it can be seen that the Triac conducts during the "ON" time pulses from the Schmitt trigger. Once the Triac is triggered, it conducts until the alternating process load current across its anode and cathode decreases to zero. Retriggering of the Triac continues until the "ON" time pulse from the Schmitt trigger ceases, and the Triac stops conducting process power.

The switching process power at zero potential level superimposes very little noise in the power line. This method has a definite advantage over phase control which creates a large amount of noise, often impairing the performance of surrounding instruments. In particular, it can cause false firing of other Triacs and SCR's controlling loads on the same line.

Triac Output Circuit (Model 32402-☐)

Isolation between the amplifier and power sections is provided by pulse transformer T2. The triggering circuit provides a voltage large enough to trigger any power SCR up to a 50 ampere rating within an ambient temperature of 32° to 120°F. Once the Triac is triggered, it conducts until the alternating process load voltage decreases to zero.

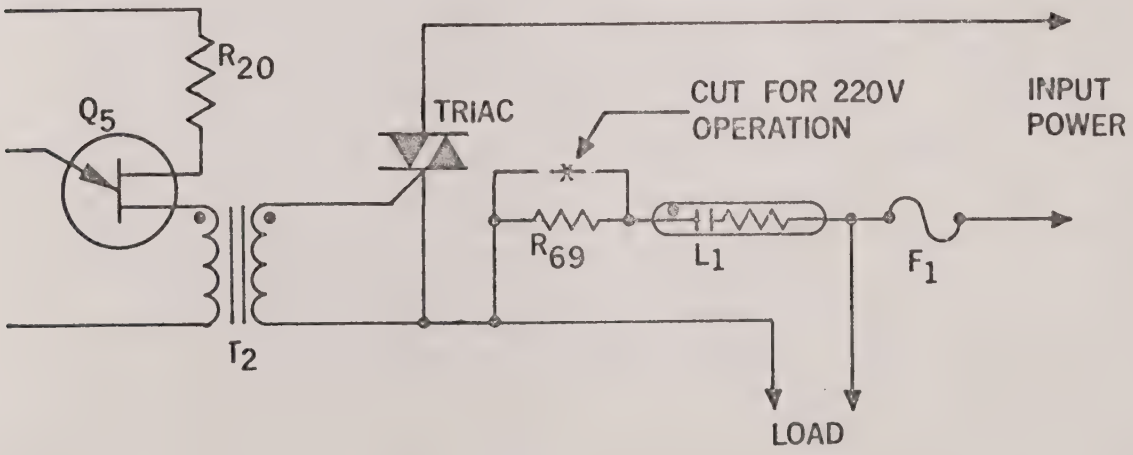


Figure 1-17. Triac Output Circuit, Model 32402

Conclusions

With an understanding of the preceeding circuit functions, the following conclusions can be drawn which describe the control functions of the indicating thermocouple controller:

1. When process temperature is much lower than setpoint level (as during start-up), the error signal from the measuring circuit is greater than 2 millivolts. The amplifier is saturated, and its output high enough to maintain a continuous charge on C3 above the intrinsic standoff voltage ratio of Q2, thus creating a continuous "ON" pulse. The Triac is repeatedly triggered and power to process load is continuous.

2. When process temperature rises well above setpoint temperature the output of Q14 increases until it is no longer sufficient to operate the voltage to current conversion circuit. At this point C3 will not charge sufficiently to be discharged by Q2, "ON" pulses cease, and power to the process stops flowing. This occurrence marks the upper limit of the proportional band.

3. The proportional band parameters are determined by the output span of Q14 which will cause the periodic discharge of C3. Varying the proportional band rheostat varies the gain of Q14, and thus widens or narrows the output span of Q14 in relation to the measuring circuit input signal. The proportional band rheostat setting then, determines the temperature span over which proportional action occurs.

4. The reset circuit is used to manually adjust the operating level of Q14. Since it has no effect on the gain of Q14, it does not affect the temperature span of the proportional band. By varying the output of Q14, however, it changes the charging rate of C3, and thus can be effectively used to adjust the percentage of "OFF" time at setpoint temperature to balance process heat losses with process load demand. It should also be noted that adjusting the reset offsets the proportional band so that it is no longer symmetrical about the setpoint.

SECTION 2-0

INSTALLATION

2-1 Unpacking

Leave the instrument in the shipping container until ready to install. In general, instruments are shipped with small accessory items in the same box. Check all items against the packing lists before discarding the shipping container and packing material.

2-2 Location

Install the controller in an area which remains within the ambient temperature limits of 40 to 120°F. If the instrument is to be mounted in a cabinet, prevent possible heat damage to the Triac and other components by providing adequate ventilation. For longest life, locate in a room with a dry, clean atmosphere.

2-3 Mounting

The instrument can be mounted in any type of panel with two screws. See the dimensioned mounting drawing in the Appendix.

2-4 Electrical Connections

All electrical connections are made to the female connector at the rear of the controller. To wire, uncouple the connector and remove its cover by removing the two cover retaining screws. Slide cover over wiring before attaching leads. Refer to Figure 2-3 for connection points.

Power Input

Connect input power to terminals 11 (common) and 12 (hot). The power selector switch must be positioned for 115 or 220 Vac operation prior to energizing the controller. In addition to switch positioning for 220 Vac operation, the jumper wire across the 47K ohm carbon resistor must be removed. Refer to Figures 2-1 and 2-2 for resistor location.

CAUTION

Standard instruments will supply process loads requiring a maximum of 15 amperes. Under no circumstances should the current ratings of the instrument be exceeded.

Grounding

Terminal 9 should be grounded in accordance with NEMA standards or other acceptable methods. Conduit grounds must be avoided, as their potential with respect to a water pipe ground is high enough to prove detrimental to the performance of the instrument.

Control Wiring

The final process control element (resistive electrical heater) should be connected directly to terminals 7 and 8 in the power plug. The instrument will not control the process if intermediate power or load relays are used.

Thermocouple Input

Use a thermocouple which matches the ISA calibration symbol printed on the low end of the setpoint scale or on the data plate. Connect to terminals 3 and 4 while observing polarity.

Figure 2-1. Power Input Jumper Wire Location (Analog)

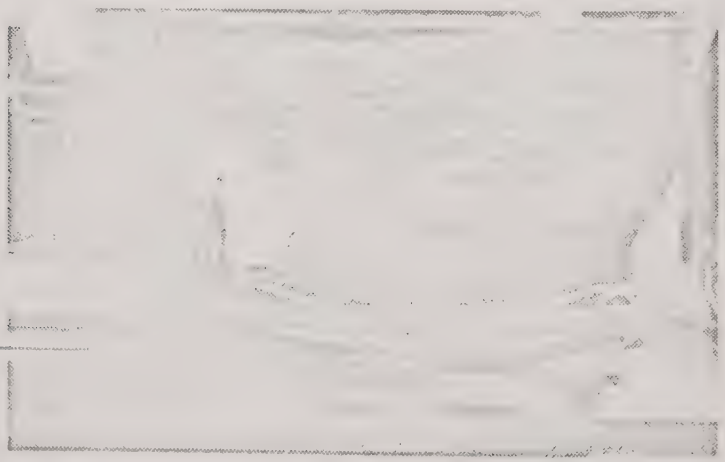
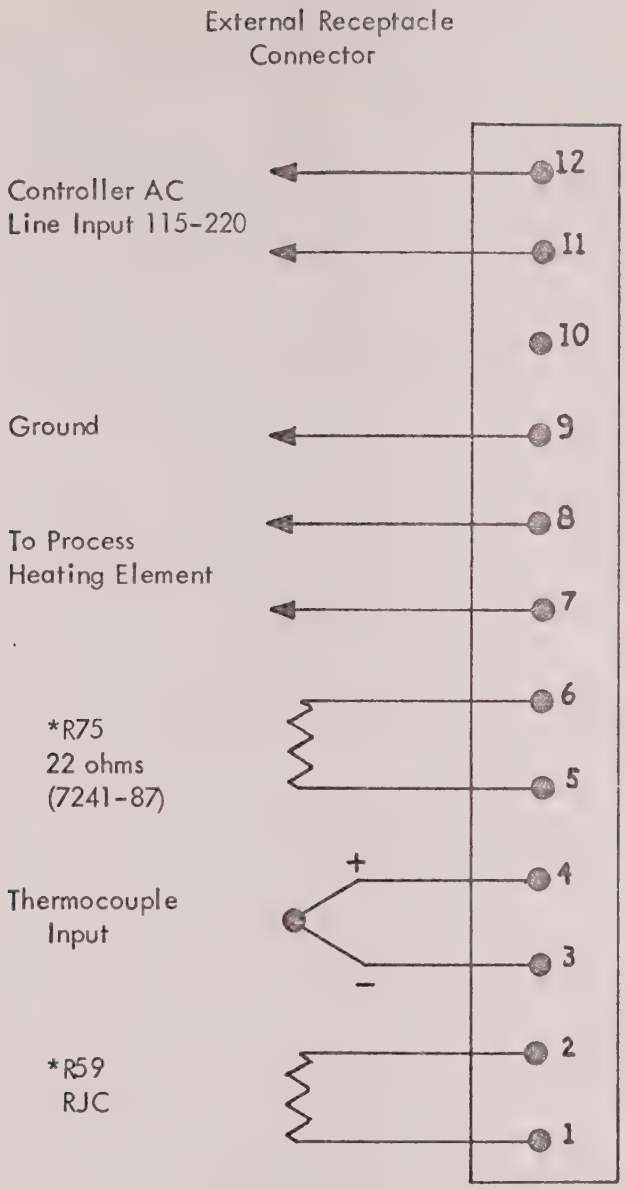


Figure 2-2. Power Input Jumper Wire Location (Digital)



*Factory installed. If replaced, the controller may have to be recalibrated.

Figure 2-3. Controller External Wiring, Model 32402

SECTION 3-0

OPERATING INSTRUCTIONS

3-1 Operating Controls

The Setpoint Thumbwheel or Knob is used to set the desired process temperature. When adjusting, stand directly in front of the controller to eliminate parallax between the hairline and scale graduations.

The Proportional Band Control is adjustable from 10° to 50° (5° to 25°C). The setting determines the process temperature level at which full power output to the process will gradually begin to decrease in proportion to the difference between process level and setpoint level.

The Reset Control is used to linearly shift the proportional band up or downscale, with reference to the setpoint. Its main function during operation is to correct for control temperature offsets caused by process load changes.

3-2 Operating Procedures

The instrument is shipped with all parts in place. After mounting and making all electrical connections as instructed in Section 2, the instrument is ready for operation. Proceed as follows:

Preliminary Adjustments and Start Up

A. Adjust the setpoint scale for the desired process temperature.

B. Rotate the Proportional Band control to a maximum counterclockwise position. This setting creates the narrowest possible proportional band.

C. Position the Reset control approximately in the center of its total rotation. This makes the proportional band span approximately equal on either side of the setpoint temperature.

D. Energize the controller. Continuous illumination of the red signalling lamp indicates that full power is being applied to the process load. As temperature rises to within 50°F of setpoint, the indicating meter will begin to move toward center scale.

E. As process temperature nears setpoint, cyclic illumination of the lamp indicates that the process has entered the proportional band. The cycle duration serves as an indication of power output. Cycle length increases as process temperature approaches setpoint temperature until a balance is obtained between controller power output and process heat losses.

F. After process temperature stabilizes, the proportional band should be widened until temperature cycling is eliminated. This is most easily accomplished by turning the Proportional Band control clockwise through a few degrees of rotation, and then waiting until the process again stabilizes. The procedure is then repeated until the indicating meter stabilizes.

It should be noted that this procedure will result in the narrowest proportional band setting necessary to properly maintain process temperature. Wider than necessary proportional band settings will also eliminate overshoot and cycling, but will leave the process more susceptible to offsets resulting from changes in process load.

G. The Reset adjustment is used to correct for process offsets caused by differences between process load demand and controller power output. Rotating the reset control clockwise will increase power output to the process and raise process temperature. Counterclockwise rotation results in settings which will reduce control temperature.

SECTION 4-0

PERIODIC MAINTENANCE AND TROUBLE SHOOTING

4-1 MAINTENANCE. No regular maintenance is required.

4-2 TROUBLE SHOOTING

4-3 General

Before attempting trouble shooting procedures, check to see:

A. if the fuse is in good condition. The fuse is located on the controller rear panel.
B. if the instrument is properly grounded.
C. if all connectors and plugs are properly attached and all connections properly made.
D. if the sensing element is intact and functioning correctly.
E. if the indicating lamp (110-125 volts) and deviation meter are in operating condition. (The instrument will control properly if either of the former is the only defective component)

To remove the perforated cover: remove the single screw located at the top of the rea section and slide the cover straight back.

To change a Triac: unsolder the leads to the gate and Main terminal 1. Main terminal 2 is threaded, so the Triac may be removed by turning in a counterclockwise direction.

This operation may be simplified by first removing the cooler from the rear panel. The new Triac should be torqued to 25 inch-pounds (or 29 Kg-cm). Use a heat sink on the terminals when resoldering leads.

To remove the printed circuit boards: grasp the circuit board edges and remove by pulling straight up; do not grasp by components. The measuring circuit printed circuit board may be removed by first unsoldering the leads and then removing the two mounting screws.

4-4 Trouble Shooting Guide

Symptom of Trouble	Possible Causes
Indicator lamp remains On, process overheating	1. Triac shorted. Remove the perforated cover and the power supply printed circuit board and check resistance between terminals 8 and 11. Resistance should be infinite. Refer to Figure 4-1 for Triac resistance measurements.
	2. Defective power supply component. Replace power supply printed circuit board and recheck operation.*

Symptom of Trouble	Possible Causes
Indicator lamp remains off, process cooling. Deviation meter does not indicate.	1. Measure line voltage at rear panel plug, terminals 11 and 12. Voltmeter indication should agree with setting of the input selector switch. Absence of voltage indicates external wire at fault.
Indicator lamp remains off, process cooling. Deviation meter indicating.	1. Fuse blown. Replace if open circuited. 2. Defective power supply component. Replace power supply printed circuit board and recheck operation.* 3. Triac open. Check resistance noted in Figure 4-1.
No proportional band	1. Defective amplifier component. Replace amplifier printed circuit board and recheck operation.*
No reset	1. Defective amplifier component. Replace amplifier printed circuit board and recheck operation.*
No meter deviation	1. Defective amplifier or power supply component. Replace one printed circuit board at a time, rechecking operation after each replacement.*
Calibration off	1. See Section 5-0 in this manual for calibration procedures.

*It may be necessary to recalibrate the controller if a printed circuit board or component is replaced. Refer to Section 5-0 for procedure.

Measurement Points	Resistance
A to B	10 to 200 ohms
B to A	10 to 200 ohms
A to C	infinity
B to C	infinity

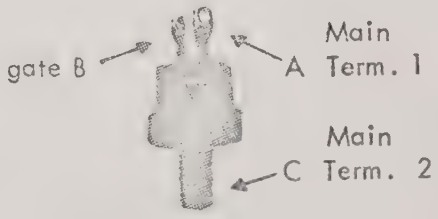


Figure 4-1. Triac Resistance Measurements

4-5 Spare Parts

The following parts are recommended to be kept on hand to facilitate fast replacement in case of failure. Thermo Electric part numbers appear in parentheses.

A. Fuse, 15 amperes (A5443)
B. Rectifier, Triac SD50D (A4748-2)
C. Neon Lamp (A5018)

SECTION 5-0

CALIBRATION AND TESTING

5-1 General

The following method of calibration is one of several available but is the one which will yield the highest degree of accuracy. Adjustment potentiometers and voltage reference points can be quickly found by referring to the schematic diagram in the Appendix.

Equipment:

A. Precision laboratory millivolt potentiometer.

B. Calibrated reference junction thermocouple with copper extension wire for cold junction simulation.

C. Voltmeter (Simpson 260 or equivalent).

D. Thermocouple Emf vs. Temperature Conversion Table, 32°F (0°C) reference temperature.

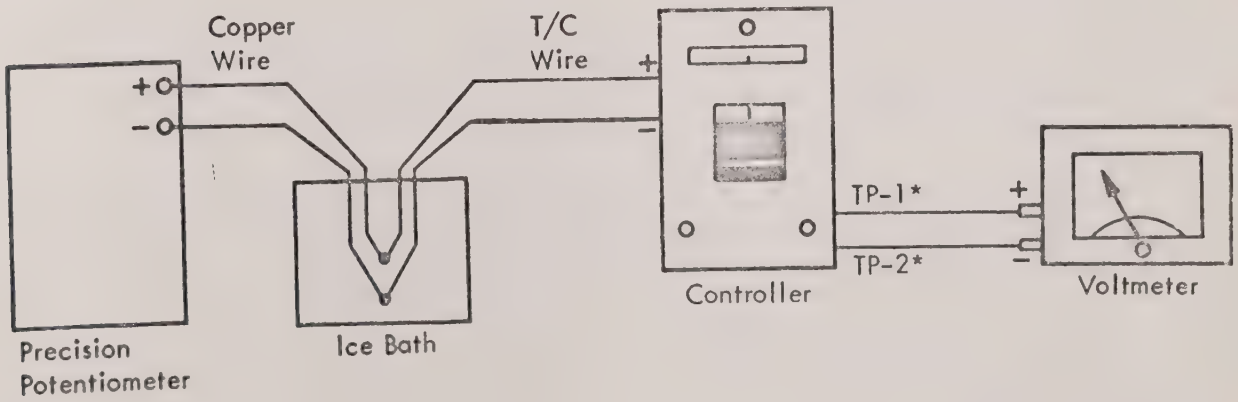
E. Ice bath, 32°F.

5-2 Controller with Analog Setpoint

Procedure:

A. Connect equipment as shown in Figure 5-1.

B. Using the Emf vs. Temperature Conversion Table, set the precision potentiometer to a millivolt value which is equivalent to the EMF value at the point which is 10% above the minimum scale value. Set the controller to this temperature.



*See schematic diagram for location of these points.

Figure 5-1. Calibration with Precision Laboratory Potentiometer

C. Adjust the controller zero adjust potentiometer R63, to obtain 1.5 Vdc ± 0.1 Vdc. Disconnect the voltmeter.

D. Adjust potentiometer R5 to balance the controller deviation meter at null. If the span of potentiometer R6 is not great enough to balance the meter, readjust zero adjust potentiometer R63 to offset the voltage by less than 0.1 Vdc.

E. Set the precision potentiometer to a millivolt value which is equivalent to the EMF value at the point which is 90% above the minimum scale value. Set the controller to this temperature.

F. Adjust span adjustment potentiometer R4 to balance the deviation meter at null.

G. Set the precision potentiometer to a millivolt value equal to the midpoint scale reading of the controller.

H. Adjust the controller setpoint until the deviation meter is balanced at null.

J. Convert the precision potentiometer to degrees F (or C) and compare the difference between the controller and potentiometer. If greater than 1/4% of full controller span (2.5°F for 0 to 1000°F) repeat step B then steps D through H to minimize the error and distribute it evenly over the scale. For highest accuracy, the error of the precision potentiometer at scale points used and the error of the thermocouple should be taken into consideration.

K. Set the controller setpoint at midscale.

L. Balance the deviation meter by adjusting the precision potentiometer.

M. Set the precision potentiometer to a value equal to 50°F above the controller setpoint.

N. Adjust potentiometer R21 to balance the deviation meter at 50°F.

P. Repeat step L; set the precision potentiometer to a value equal to 50°F below the controller setpoint. Repeat step N.

Q. Adjust the precision potentiometer to millivolt values equal to 25°F above and below setpoint. At each point the deviation meter error should be less than + one meter increment. If the error is greater, repeat steps M through P to minimize the error.

R. Select four random controller setpoints and check the accuracy of each. Accuracy should be within + 1/4% of full scale span. Repeated adjustment is sometimes necessary to obtain an even distribution of error throughout the scale span.

5-3 Controller with Digital Setpoint

Procedure:

A. Connect equipment as shown in Figure 5-1.

B. Using the Emf vs. Temperature conversion table, set the precision potentiometer to a millivolt value which is equal to approximately 10% of the controller's calibrated range. (Controllers with a digital setpoint may have a 0 to 1000 digital dial but can only be calibrated for a 0 to 600° range. Refer to the data plate at the rear of the instrument for the calibrated range.) Set the controller to this temperature.

C. Adjust the controller zero adjust potentiometer R63, to obtain 1.5 Vdc ± 0.1 Vdc. Disconnect the voltmeter.

D. Adjust potentiometer R6 to balance the controller deviation meter at null. If the span of potentiometer R6 is not great enough to balance the meter, readjust zero adjust potentiometer R63 to offset the voltage by less than 0.1 Vdc.

E. Set the precision potentiometer to a millivolt value which is equal to approximately 90% of the controller's calibrated range. Set the controller to this temperature.

F. Adjust potentiometer R67 to balance the deviation meter at null.

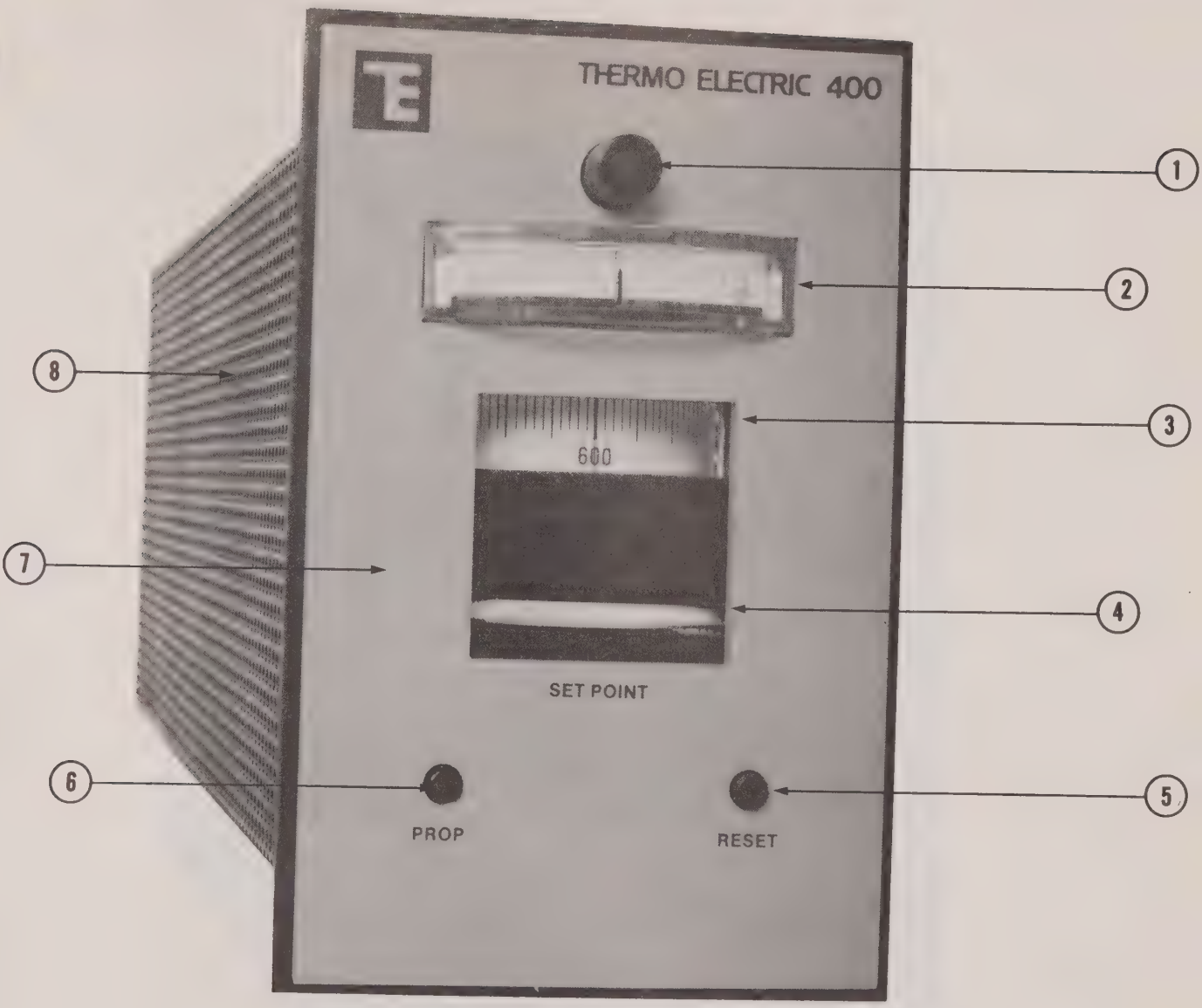
G. Set the precision potentiometer to a millivolt value equal to the midpoint of the controller's calibrated range.

H. Adjust potentiometer R66 to balance the deviation meter at null.

J. Repeat step B.

K. Convert the precision potentiometer to degrees F (or C) and compare the difference between the potentiometer and controller. If greater than 1/2% of total span of calibrated range (3°F for 0 to 600°F) repeat step B then steps D through H to minimize the error and distribute it evenly over the calibration span. For highest accuracy, the error of the precision potentiometer at scale points used and the error of the thermocouple should be taken into consideration.

6-0 APPENDIX

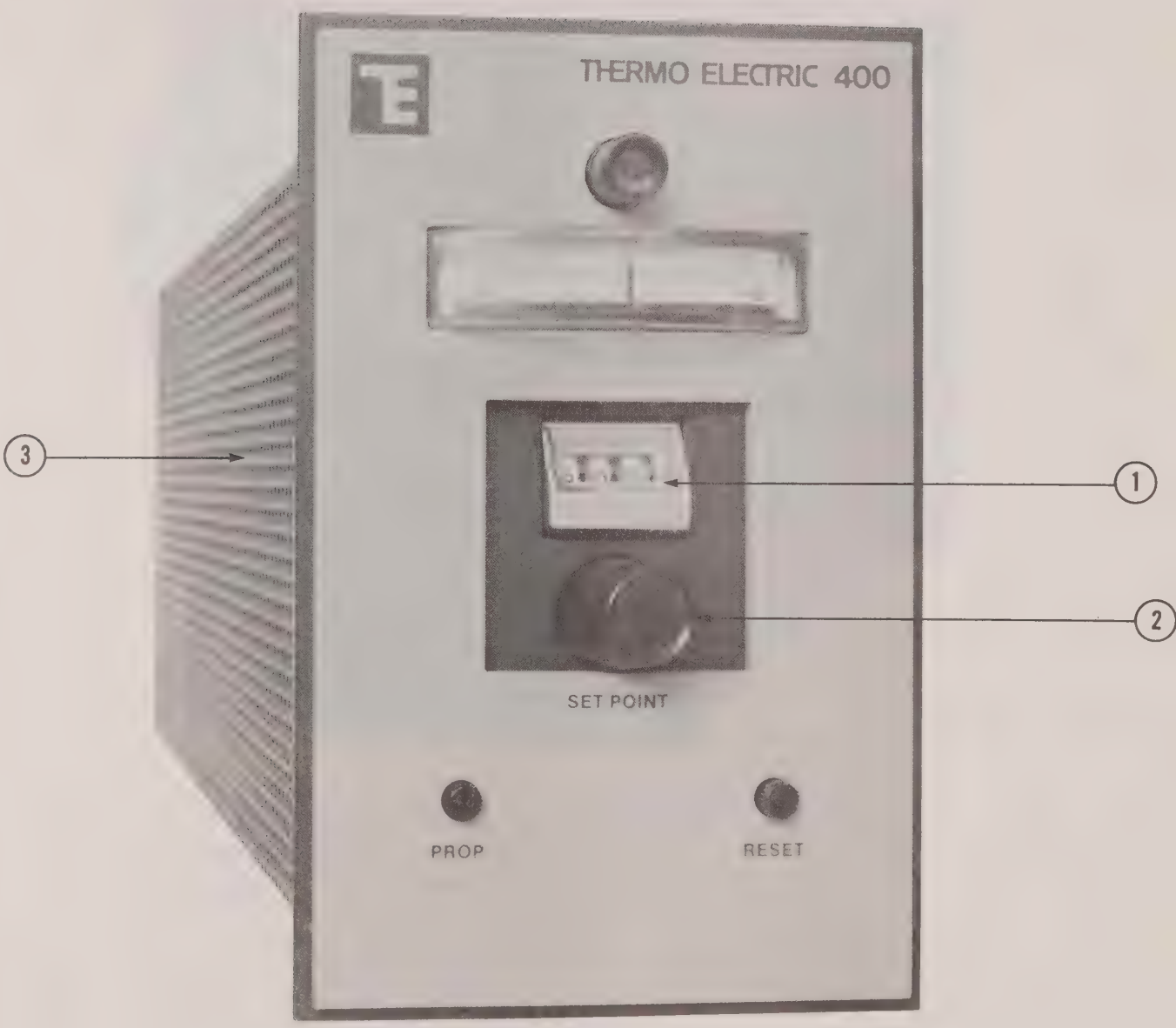


Analog Setpoint Model Illustrated

1. Indicator lamp ass'y. (A4870; G.E. NE-2J neon bulb A5018)
2. Indicating deviation meter (A4869 -☐)*
3. Setpoint scale (window part number: A1754)
4. Setpoint thumbwheel
5. Manual Reset control (R56, dual potentiometer A4747)
6. Proportional Band control (R55, potentiometer A4761)
7. Front Panel (A6022-1)
8. Ventilated case (A6504)

Thermo Electric part numbers appear in parentheses

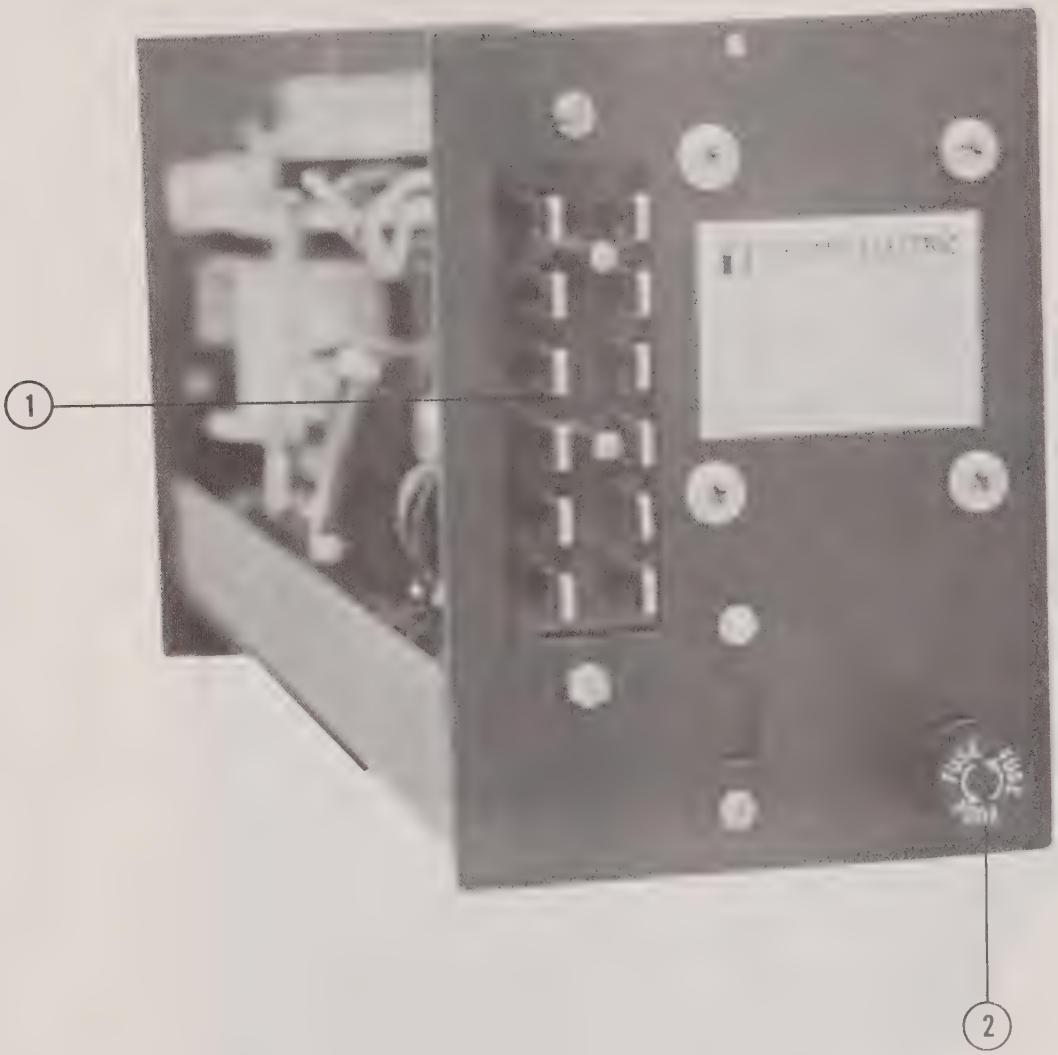
* - 1 for Fahrenheit scale
  - 2 for Centigrade scale
  - 3 for High Gain Model with Fahrenheit scale
  - 4 for High Gain Model with Centigrade scale



Digital Setpoint Model Illustrated

1. Digital turns counting dial (A4974)
   Potentiometer, dual ganged 100 ohms, not shown (A4762)
2. Setpoint Knob (A5847)
3. Range Card and Measuring Circuit Printed Circuit Board assembly, not shown (A5564)*

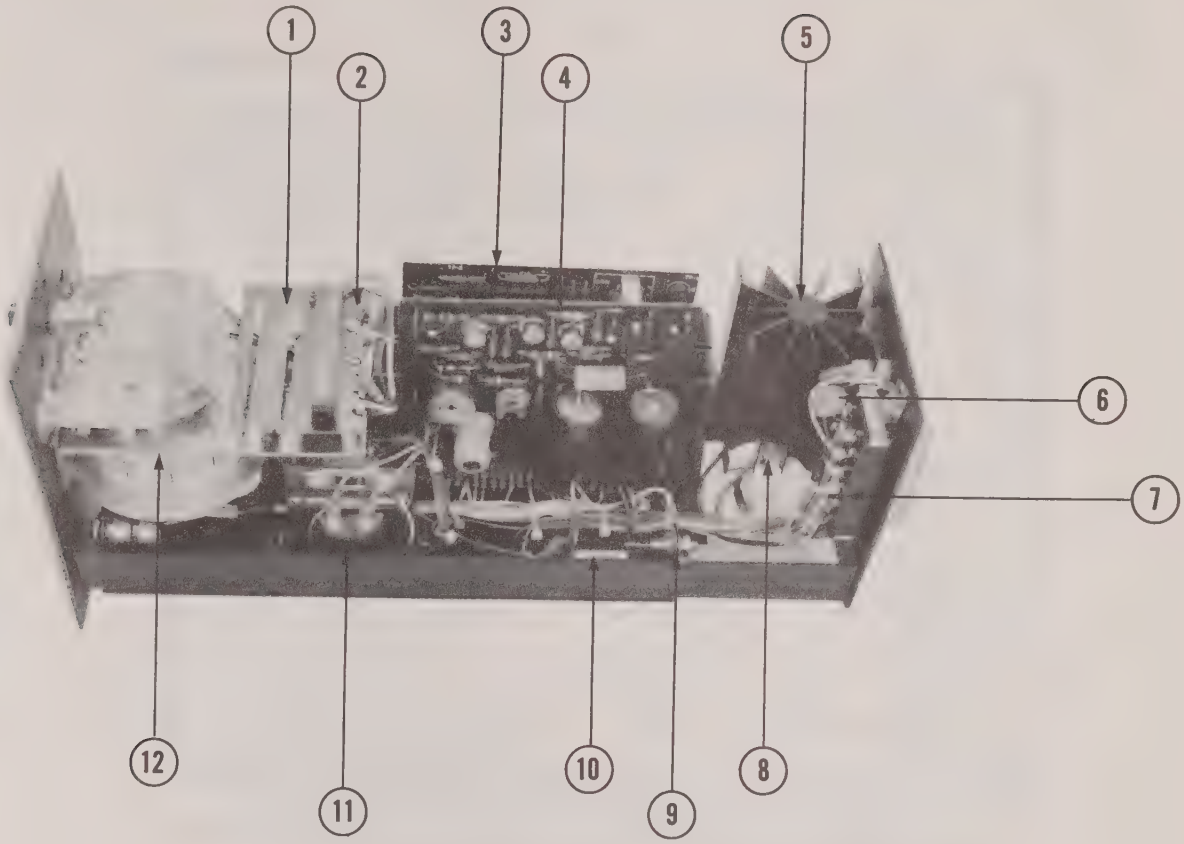
Thermo Electric part numbers appear in parentheses.
*Specify calibration and calibration range when ordering.



Model 32402 Illustrated

1. Plug (A5254) mating socket not shown (A5255)
   R59, 15 ohm compensating resistor located in mating socket (A1780-☐)*
   R75, 22 ohm resistor located in mating socket (7241-87)
2. Fuse, 15 amperes (A5443) fuse holder (7140) and fuse cap

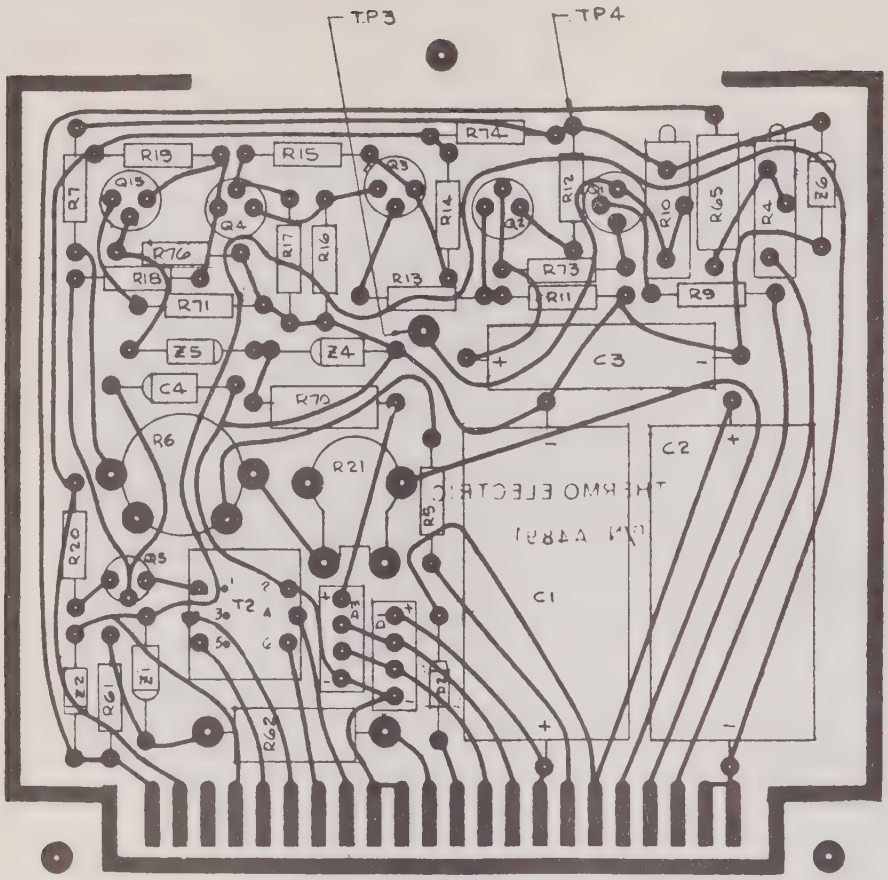
Thermo Electric part numbers appear in parentheses.
*Specify ISA calibration when ordering.



Model 32402 Illustrated

1. Range card and measuring circuit. P.C. board assembly (A5544)*
2. R69, 47K ohm resistor (7241-12) (Adjacent to power transformer for digital controller)
3. Amplifier P.C. board assembly (A4894)
4. Power Supply P.C. board assembly (A4892)
5. Semi-conductor cooler (A5364)
6. C18, 19, .01 mfd. capacitors (7902)
7. R75, 22 ohm resistor (7241-87)
8. Rectifier, Triac SC50D (A4748-2)
9. Z3, Zener diode IN2980A or ZS16A (A4735)
10. R8, 100 ohm resistor, 5 watt (A5472-2)
11. Transformer and switch assembly (A6236)
12. Baseplate and slidewire assembly (A4952)**

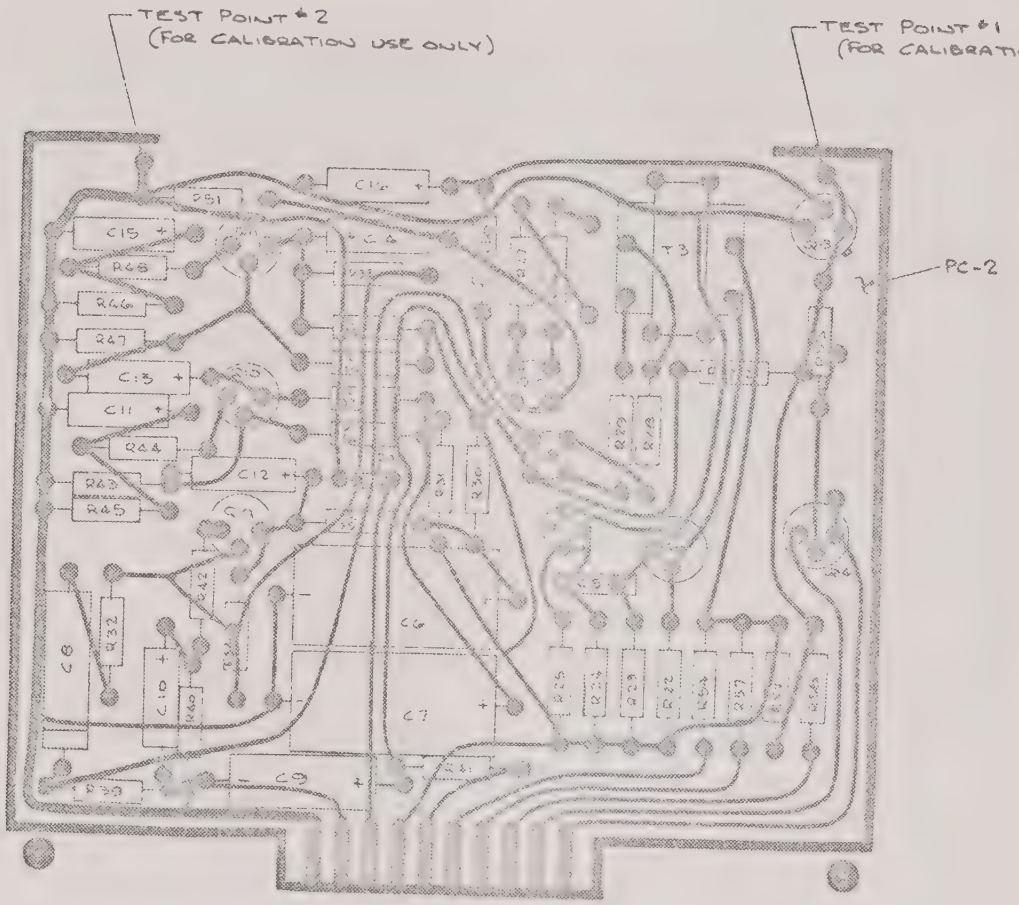
Thermo Electric part numbers appear in parentheses.
*Specify scale dash number (7551-☐) and calibration when ordering.
**For individual parts, request drawing and parts list A4952.



PC1	Printed circuit board (A4891)
Z1	Zener diode ZA18A (A4260)
Z2	Zener diode IN821 (A4736)
Z4	Zener diode ZA18A (A4260)
Z5	Zener diode ZA13A (A5469)
Z6	Zener diode ZA17A (A5237)
D1	Full wave bridge rectifier FW200 (A4450)
D2	Diode IN4003 (A4473)
D3	Full wave bridge rectifier FW200 (A4450)
Q1	Transistor 2N3638A (A5613)
Q2	Transistor 2N1671 (A4733)
Q3	Transistor 2N1304 (A4734)
Q4	Transistor 2N1304 (A4734)
Q5	Transistor 2N2647 (A5468)
Q15	Transistor 2N3568 (A4729)
C1	500 mfd. capacitor, 50 WVDC (A4738)
C2	500 mfd. capacitor, 50 WVDC (A4738)
C3	50 mfd. capacitor, 25 WVDC (A4882)
C4	.1 mfd. capacitor (A5487)
R4	1 K potentiometer (A5241) (not functional with digital setpoint)
R5	360 ohm resistor ± 5% (7241-99)
R6	200 ohm potentiometer (A4264-4)
R7	5.1 K ohm resistor (7241-58)

R9	18 K ohm resistor (7241-39)
R10	5 K potentiometer (A5608)
R11	620 ohm resistor (7241-89)
R12	390 ohm resistor (7241-80)
R14	3.3 K ohm resistor (7241-41)
R15	15 K ohm resistor (7241-53)
R16	470 ohm resistor ± 5% (7241-70)
R17	18 K ohm resistor (7241-39)
R18	1.2 K ohm resistor + 5% (7241-105)
R19	2.7 K ohm resistor ∓ 5% (7241-104)
R20	100 ohm resistor (7241-101)
R21	10 K ohm potentiometer (A4740)
R61	1 K ohm resistor (7241-22)
R62	1.5 K ohm resistor, 2 watt (7243-6)
R65	2370 ohm resistor, 1% (A3849-85) (not functional with digital setpoint)
R70	1 K ohm resistor, 1 watt (7242-39)
R71	270 ohm resistor + 5% (7241-90)
R73	100 ohm resistor (7241-101)
R74	390 ohm resistor (7241-80)
T2	Pulse Transformer 11Z400 (A5586)

All carbon resistors 1/2 watt unless otherwise specified.
Thermo Electric part numbers appear in parentheses.



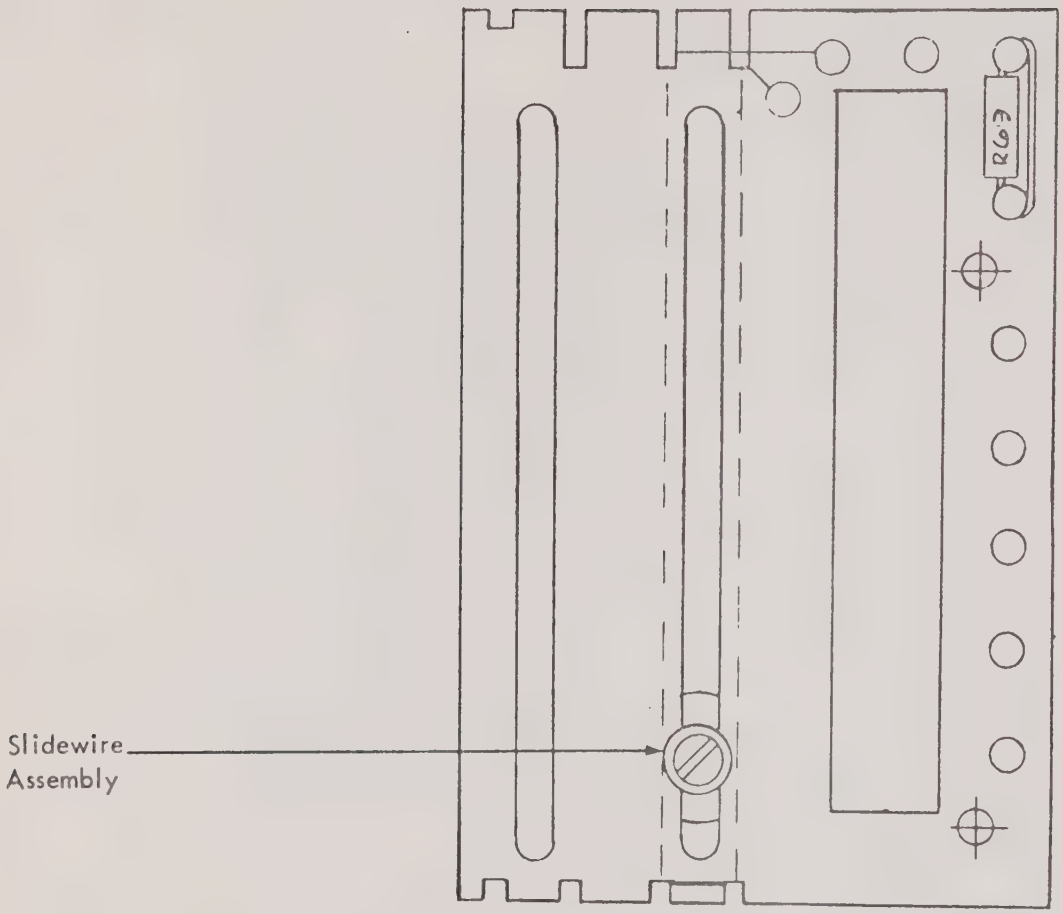
PC-2	Printed circuit board (A4893)
Q6	Transistor 2N3568 (A4729)
Q7	Transistor 5E35 (A4730)
Q8	Transistor 3N88 (A4731)
Q9	Transistor 2N3566 (A4066)
Q10	Transistor 2N3566 (A4066)
Q11	Transistor 2N3566 (A4066)
Q12	Transistor 3N88 (A4731)
Q13	Transistor 2N3638 (A4732)
Q14	Transistor 2N3566 (A4066)
T3	Transformer UTC-SO-16 (A4742)
	Bracket for above (A4745)
C5	.01 mfd capacitor, 25VDC (7902)
C6	100 mfd capacitor, 25VDC (A4737)
C7	100 mfd capacitor, 25VDC (A4737)
C8	.1 mfd capacitor, 150 VDC (A4443)
C9	100 mfd capacitor, 10VDC (A5234)

C10 thru C16	15 mfd capacitor, 20 VDC (A5235)
R22	1.2 K ohm resistor (7241-62)
R23	33 k ohm resistor (7241-31)
R24	12 k ohm resistor (7241-54)
R25	470 ohm resistor (7241-70)
R26 thru R29	1.8 k ohm resistor ± 5% (7241-88)
R30	4.7 k ohm resistor (7241-24)
R31	1 k ohm resistor (7241-22)
R32	1 k ohm resistor (7241-22)
*R33	2.2 meg ohm resistor (7241-3) (not used on A5550)
R34	33 k ohm resistor (7241-31)
R35	10 k ohm resistor (7241-13)
R36	12 k ohm resistor (7241-54)
R37	1.5 k ohm resistor (7241-25)
R38	4.7 k ohm resistor (7241-24)
R39	2.2 k ohm resistor (7241-21)
R40	2.2 k ohm resistor (7241-21)
R41	1 k ohm resistor (7241-22)
R42	22 ohm resistor (7241-87)
R43	4.7 k ohm resistor (7241-24)
R44	15 ohm resistor (7241-47)
R45	680 ohm resistor (7241-75)
R46	330 ohm resistor (7241-14)
R47	1.5 k ohm resistor (7241-25)
R48	15 ohm resistor (7241-47)
R49	820 ohm resistor (7241-81)
R50	430 ohm resistor (7241-71)
R51	1 k ohm resistor (7241-22)
R52	10 k ohm resistor (7241-13)
R53	4.7 k ohm resistor (7241-24)
R54	1.5 k ohm resistor (7241-25)
R57	1.8 k ohm resistor ± 5% (7241-88)
*R58	3.3 k ohm resistor ± 5% (7241-79) for A4894, 2.2 k ohm (7241-21) for A5550
R72	10 meg ohm resistor (7241-1)
D4	1N4001 Diode (A5005)

All resistors 1/2 watt, ± 10% unless otherwise specified.
Thermo Electric part numbers appear in parentheses

* Value may vary. Refer to schematic diagrams.

Range Card and Measuring Circuit PC Board Assembly (A5544)



PC-3		Printed Circuit Board	(A6232)
R1 R2 R3	Encapsulated Range Card Resistors	Value depends upon range of instrument	(A4791-□)
R60	Resistor	1004.3 ohms	(7670-281)
R64	Resistor	400 ohms	(A5242)
Slidewire Assembly		Zero adjust	

All Resistors ± 1%

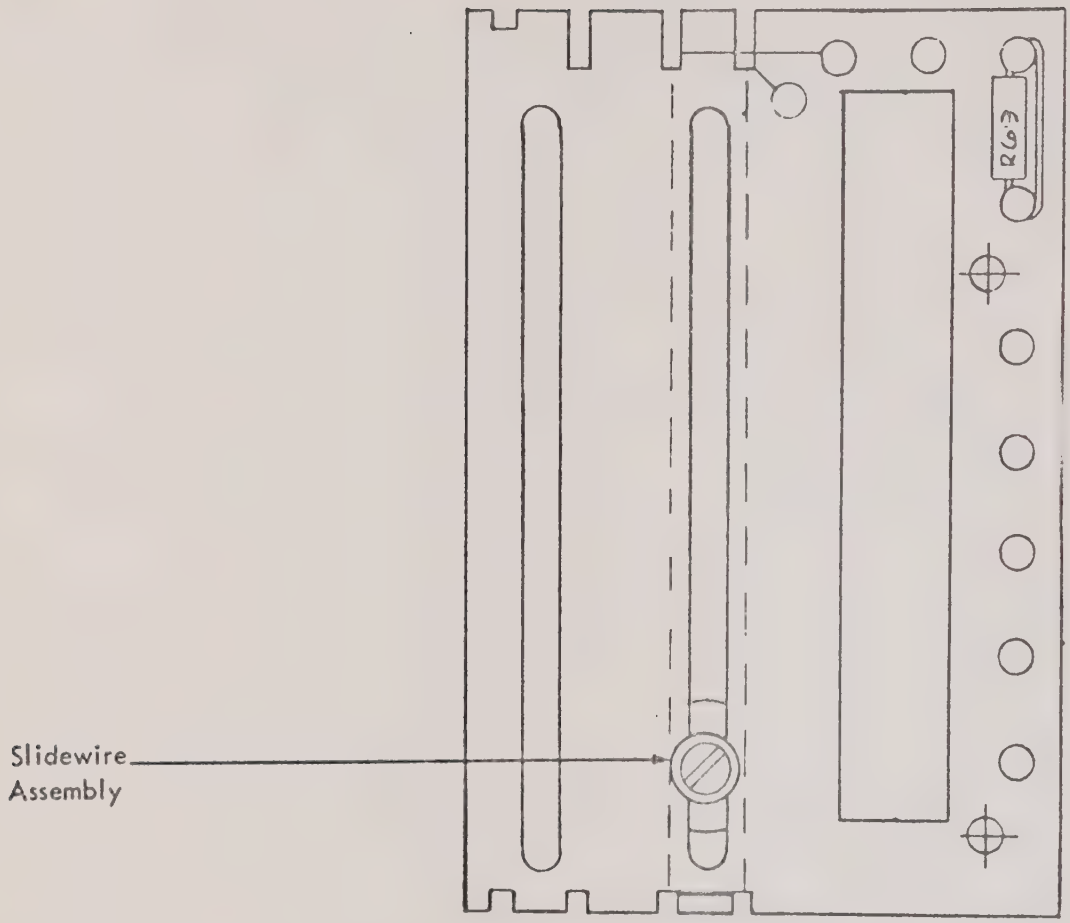
Thermo Electric part numbers appear in parentheses

C10 thru C16	15 mfd capacitor, 20 VDC (A5235)
R22	1.2 K ohm resistor (7241-62)
R23	33 k ohm resistor (7241-31)
R24	12 k ohm resistor (7241-54)
R25	470 ohm resistor (7241-70)
R26 thru R29	1.8 k ohm resistor ± 5% (7241-88)
R30	4.7 k ohm resistor (7241-24)
R31	1 k ohm resistor (7241-22)
R32	1 k ohm resistor (7241-22)
*R33	2.2 meg ohm resistor (7241-3) (not used on A5550)
R34	33 k ohm resistor (7241-31)
R35	10 k ohm resistor (7241-13)
R36	12 k ohm resistor (7241-54)
R37	1.5 k ohm resistor (7241-25)
R38	4.7 k ohm resistor (7241-24)
R39	2.2 k ohm resistor (7241-21)
R40	2.2 k ohm resistor (7241-21)
R41	1 k ohm resistor (7241-22)
R42	22 ohm resistor (7241-87)
R43	4.7 k ohm resistor (7241-24)
R44	15 ohm resistor (7241-47)
R45	680 ohm resistor (7241-75)
R46	330 ohm resistor (7241-14)
R47	1.5 k ohm resistor (7241-25)
R48	15 ohm resistor (7241-47)
R49	820 ohm resistor (7241-81)
R50	430 ohm resistor (7241-71)
R51	1 k ohm resistor (7241-22)
R52	10 k ohm resistor (7241-13)
R53	4.7 k ohm resistor (7241-24)
R54	1.5 k ohm resistor (7241-25)
R57	1.8 k ohm resistor ± 5% (7241-88)
*R58	3.3 k ohm resistor ± 5% (7241-79) for A4894, 2.2 k ohm (7241-21) for A5550
R72	10 meg ohm resistor (7241-1)
D4	1N4001 Diode (A5005)

All resistors 1/2 watt, ± 10% unless otherwise specified.
Thermo Electric part numbers appear in parentheses

* Value may vary. Refer to schematic diagrams.

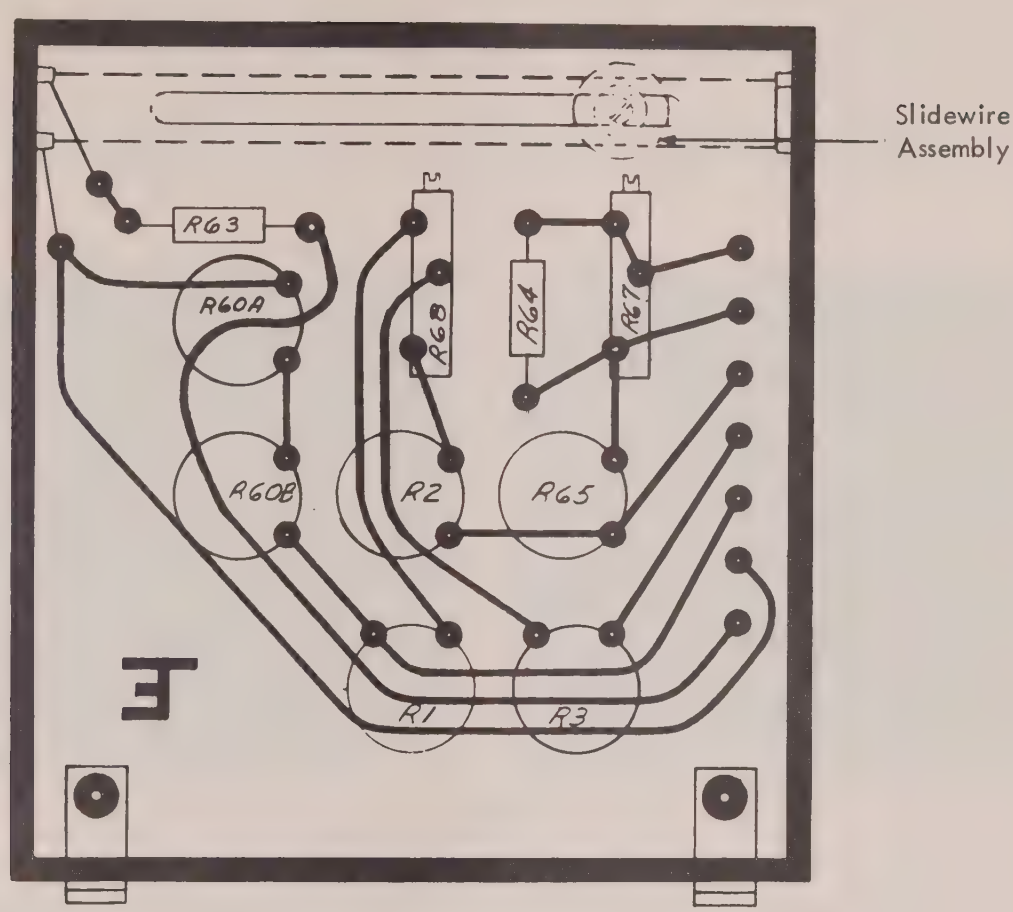
Range Card and Measuring Circuit PC Board Assembly (A5544)



PC-3		Printed Circuit Board	(A6232)
R1 R2 R3	Encapsulated Range Card Resistors	Value depends upon range of instrument	(A4791-□)
R60	Resistor	1004.3 ohms	(7670-281)
R64	Resistor	400 ohms	(A5242)
Slidewire Assembly		Zero adjust	

All Resistors ± 1%

Thermo Electric part numbers appear in parentheses

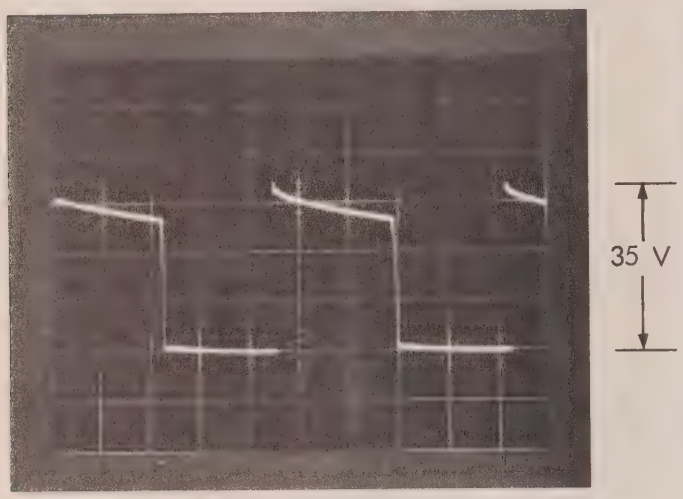


PC-3		Printed Circuit Board	(A5563)
R1	Range	Value	
R2		depends	
R3	Card	upon	(A5535-□)
R65		range of	
	Resistors	instrument	
R63	Resistor	Selected at Calibration	(A3849-□)
R60 A	Resistor	3090.0 ohms	(7670-311)
R60 B	Resistor	3090.0 ohms	(7670-311)
R64	Resistor	200 ohms	(A3849-17)
R67	Potentiometer	200 ohms	(A5365)
R68	Potentiometer	500 ohms	(A5718)
Slidewire Assembly		Zero adjust	

Thermo Electric part numbers appear in parentheses.

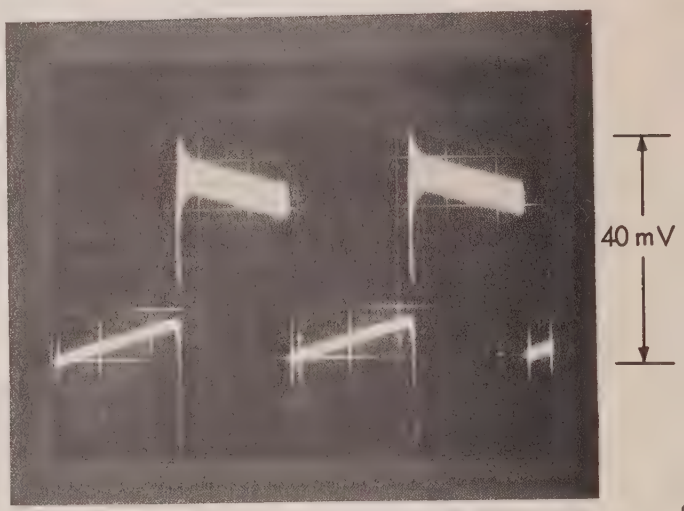
See schematic diagram for scope check points. All wave form voltages are approximate.

Preliminary: Jumper thermocouple input terminals 1 and 2 with a short length of copper wire. Balance the deviation meter at null.



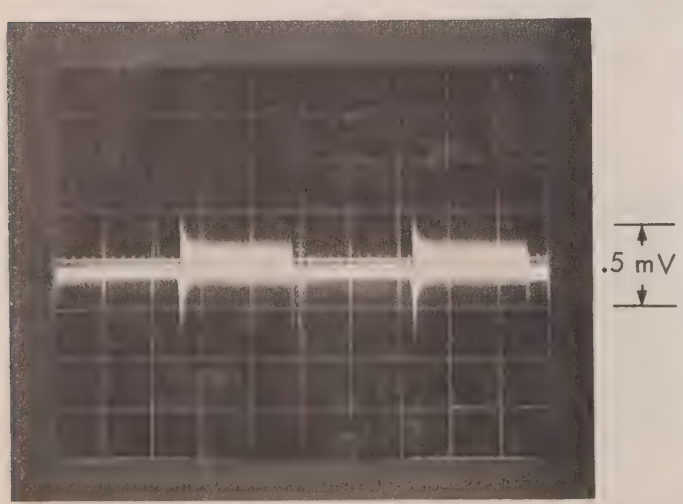
A

2 to 4 kHz
Instrument at Setpoint



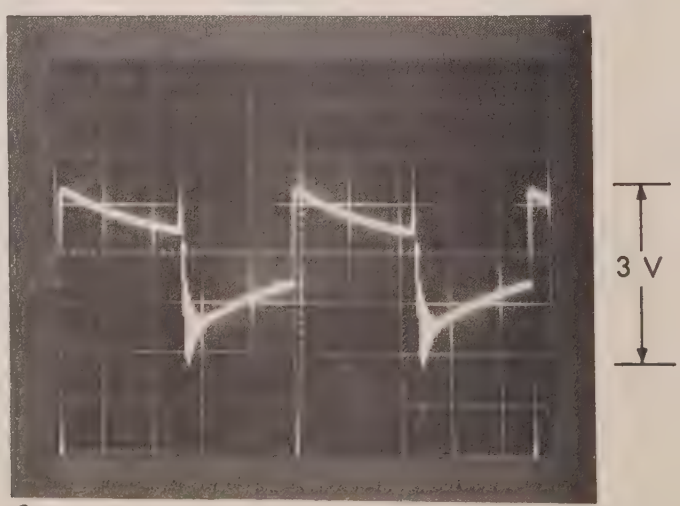
B

2 to 4 kHz
Instrument at Maximum
Deviation from Setpoint



B_1

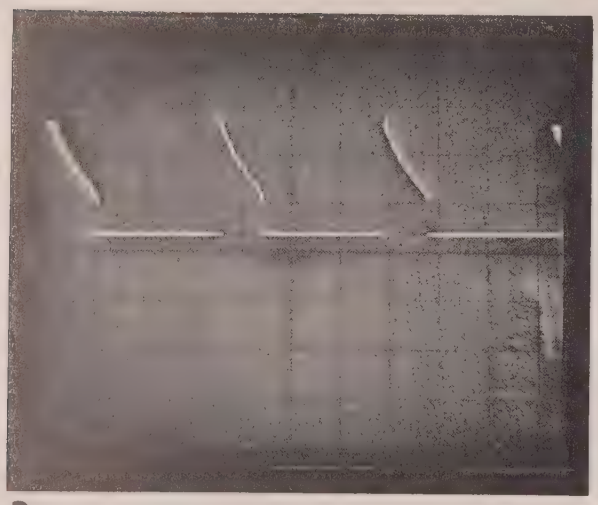
2 to 4 kHz
Instrument at Setpoint



C

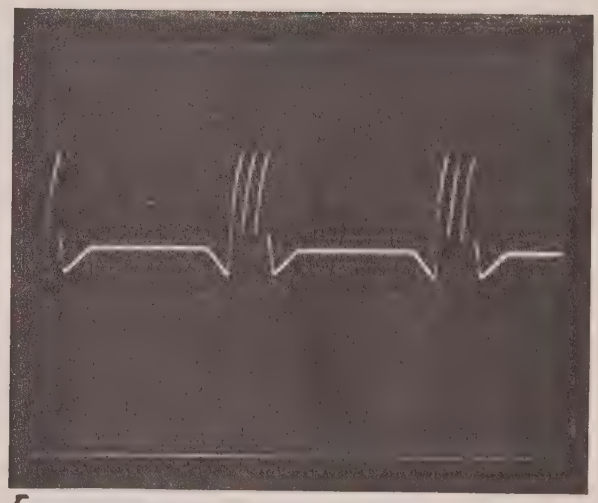
2 to 4 kHz
Instrument at Setpoint

Preliminary: Set proportional band fully clockwise (maximum). Balance the deviation meter at null.



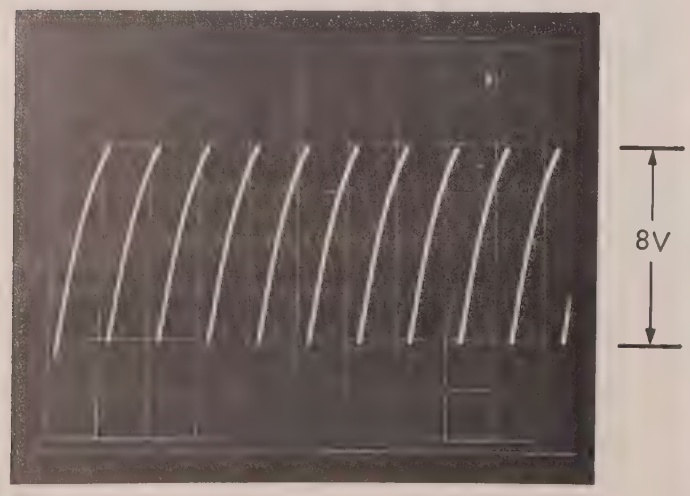
D

3 Hz
Reset adjusted for approximately equal on-off time



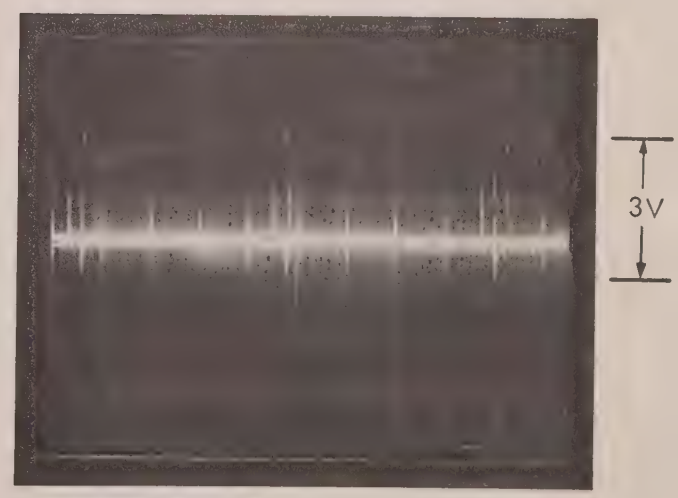
E

120 Hz
Reset fully clockwise



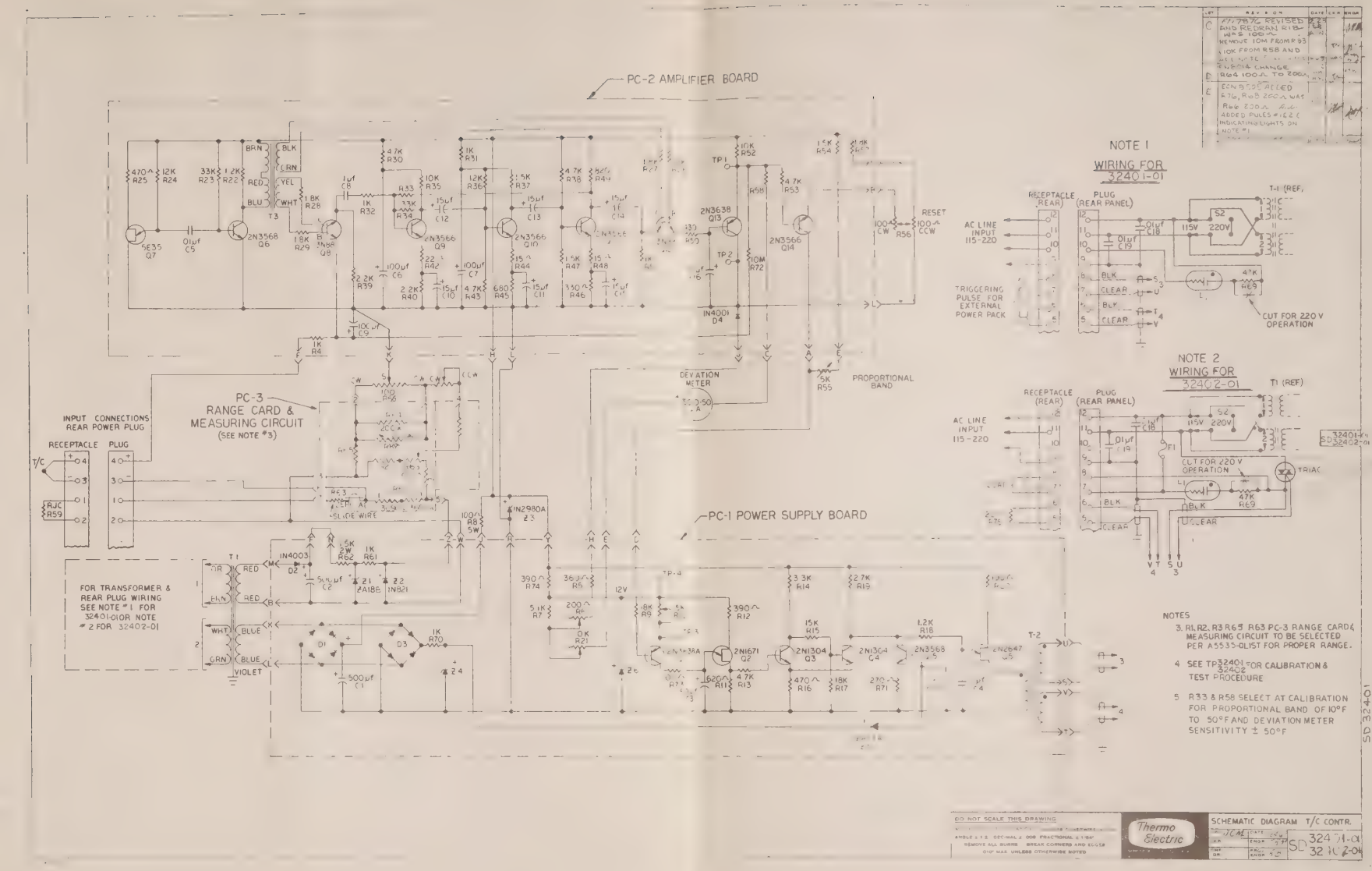
E_1

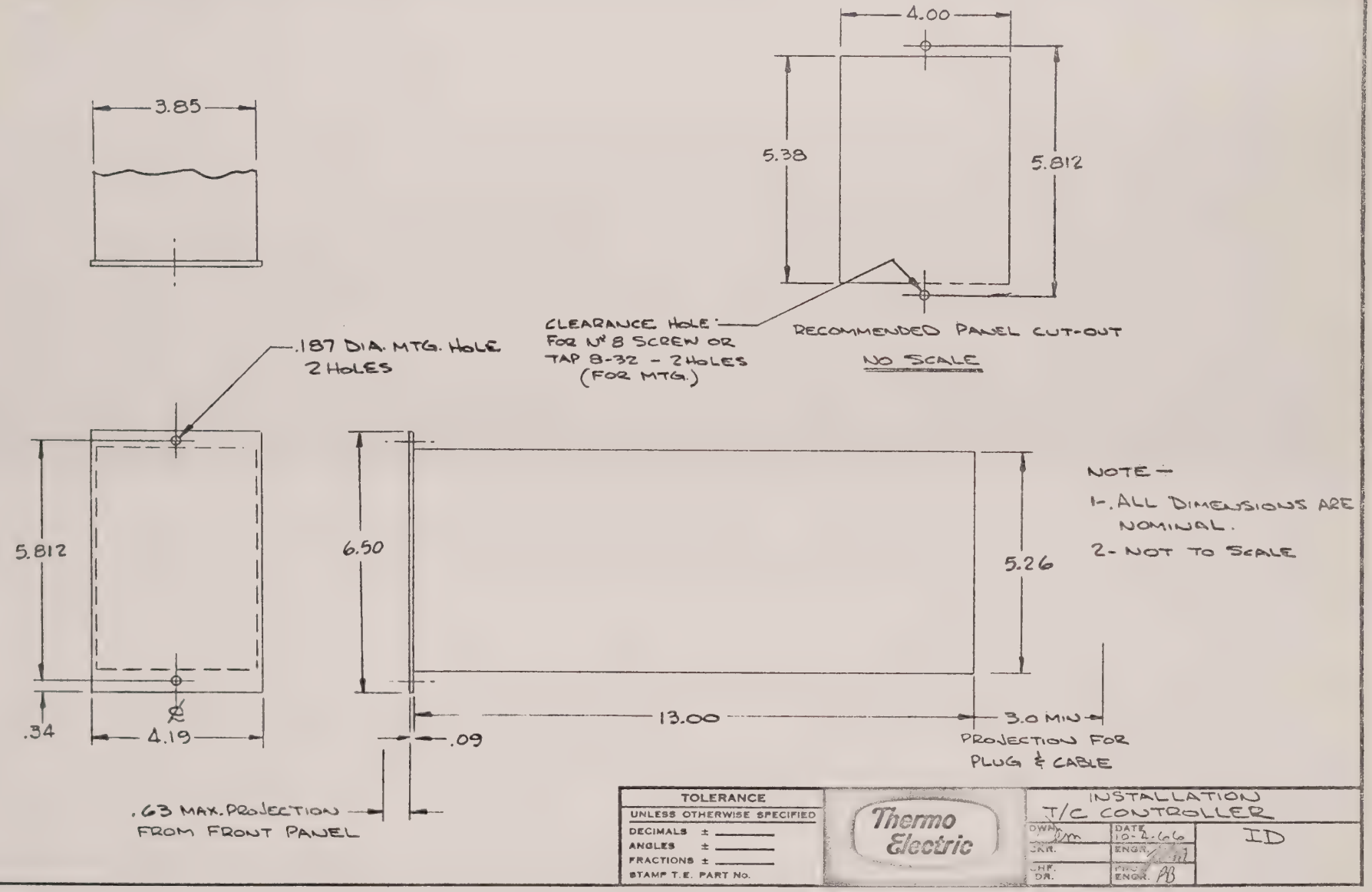
2 kHz
Transistor Q15 removed
(No zero crossing).
Reset fully clockwise



F

120 Hz
Reset fully clockwise
(Only two triggers may be visible)


PC-2 AMPLIFIER BOARD
PC-3
RANGE CARD &
MEASURING CIRCUIT
(SEE NOTE #3)
PC-1 POWER SUPPLY BOARD
INPUT CONNECTIONS
REAR POWER PLUG
RECEPTACLE
PLUG
T/C
RJC
R59
FOR TRANSFORMER &
REAR PLUG WIRING
SEE NOTE # 1 FOR
32401-01 OR NOTE
2 FOR 32402-01
DEVIATION
METER
PROPORTIONAL
BAND
5K
R55
RESET
100Ω CW
100Ω CCW
R56
NOTE 1
WIRING FOR
32401-01
NOTE 2
WIRING FOR
32402-01
AC LINE
INPUT
115-220
TRIGGERING
PULSE FOR
EXTERNAL
POWER PACK
CUT FOR 220 V
OPERATION
T1 (REF)
TRIAC
NOTES
3. R1, R2, R3, R63, R63 PC-3 RANGE CARD &
MEASURING CIRCUIT TO BE SELECTED
PER A5535-01 LIST FOR PROPER RANGE.
4 SEE TP 32401 FOR 32402 FOR CALIBRATION &
TEST PROCEDURE
5 R33 & R58 SELECT AT CALIBRATION
FOR PROPORTIONAL BAND OF 10°F
TO 50°F AND DEVIATION METER
SENSITIVITY ± 50°F
SD 32401
SD 32402
DO NOT SCALE THIS DRAWING
Thermo Electric
SCHEMATIC DIAGRAM T/C CONTR.
SD 32401-01
SD 32402-01



TOLERANCE			
UNLESS OTHERWISE SPECIFIED			
DECIMALS ±			
ANGLES ±			
FRACTIONS ±			
STAMP T.E. PART No.			

Thermo Electric

INSTALLATION
T/C CONTROLLER

DWN.	DATE 10-4-66		ID
CKR.	ENGR.		
HF. DR.	ENG. ENGR. PB		

SECTION 7-0

ADDENDUM

7-1 Variations on Construction

A. High and Low Alarm (For Models 32402-02, 03, 10 and 11)

High and low alarm provides the process with a visual indication of an over or under temperature condition. An internal alarm relay provides a set of contacts wired to the rear connector which may be used to start or stop auxiliary equipment should an alarm condition occur. High alarm or Low alarm may be removed from the circuit by turning the undesired alarm potentiometer fully clockwise or counterclockwise respectively.

1. Specifications

a. Alarm lamp and relay "latching" with common manual reset button on front panel
b. High and Low alarm potentiometers individually adjustable from $\pm$ 2 to 50°F of setpoint
c. Relay contacts are SPDT rated at 1 ampere at 125 Vac. Contacts are accessible at rear connector. Refer to attached alarm circuit schematic diagram.
d. Alarm resolution is 1°F and stability is $\pm$ 1°F.

2. Description of Operation

The High-Low alarm circuitry derives its signal from the emitter of transistor Q13. This signal is inverted, amplified and used to control two transistors connected to serve as voltage controlled current sources. These transistors control the charging of capacitors C21 and C20 in the high and low alarm trigger circuits. The trigger circuits operate a single silicon controlled rectifier (SCR) which controls the alarm lamp and relay coil. Since the SCR supply is a dc voltage, it will remain in the conducting state until the dc supply is disconnected momentarily. This is accomplished by operating the manual reset switch. Adjustment of the high and low alarm function is accomplished with potentiometers mounted on the front panel. Each instrument is shipped with the alarms set at + 10°F unless otherwise specified. The low alarm trigger point may be adjusted further below setpoint by rotating the low alarm pot counterclockwise. The high alarm trigger point may be adjusted further above setpoint by rotating the high alarm pot clockwise.

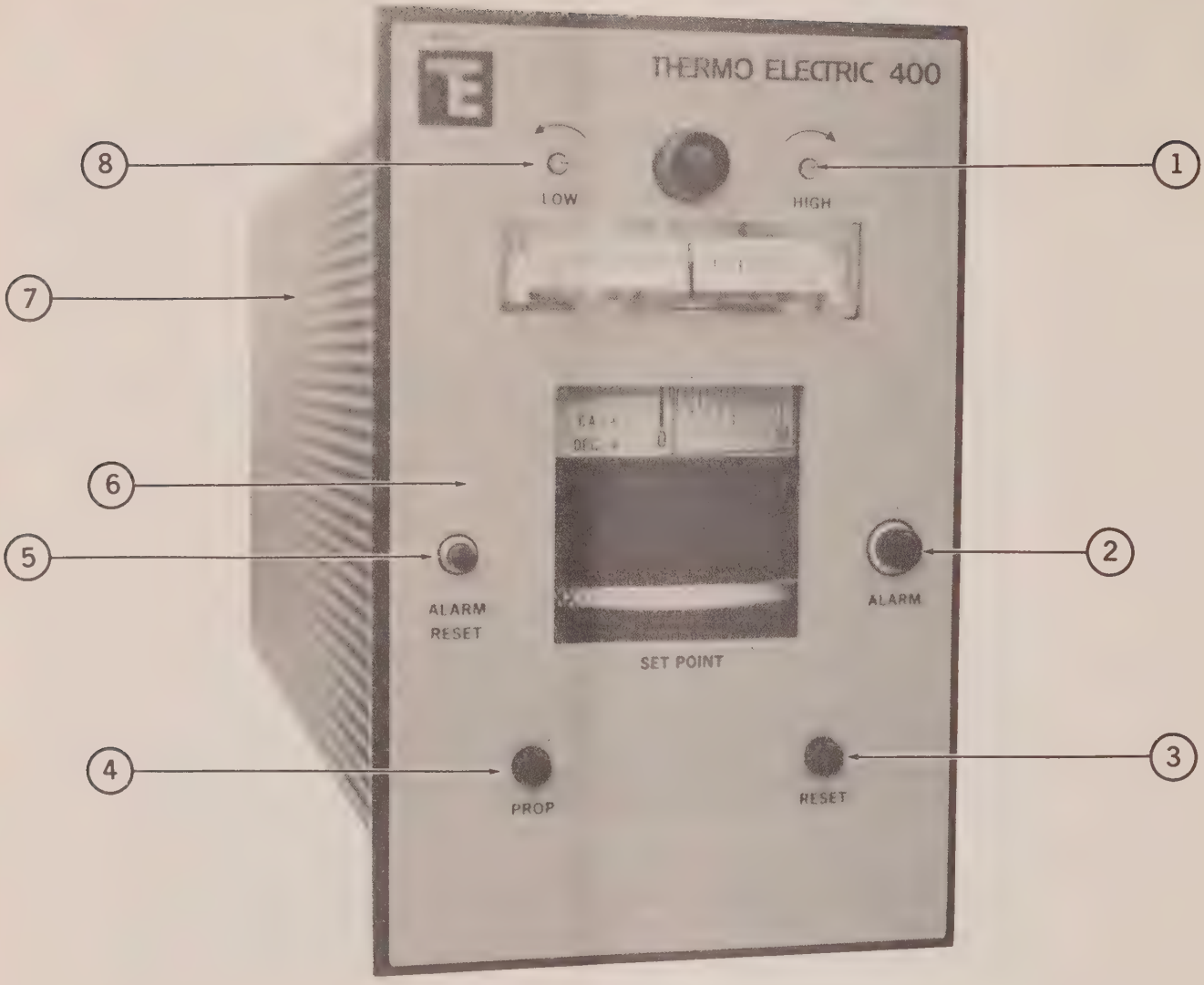
3. Calibration

There are no calibration requirements for the alarm circuit board. If there is improper operation the controller should be checked and calibrated. The relay coil and lamp should also be checked to insure that they are in proper working order.

4. Spare Parts

The following parts are recommended to be kept on hand for fast replacement in case of failure:

a. relay (A1477)
b. alarm lamp (A5446)

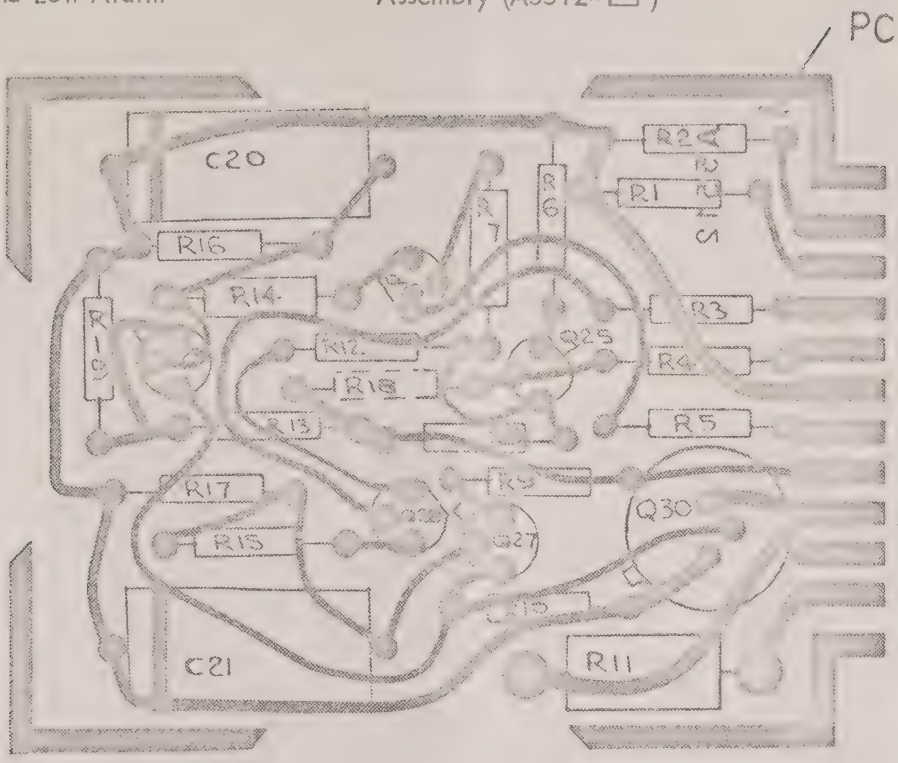


1. High Alarm adjustment (A5554)
2. Alarm indicator lamp ass'y. (A5446)
3. Manual Reset control*
4. Proportional Band control*
5. Alarm Reset switch (A5039)
6. Front Panel (A6022-2)**
7. Ventilated (perforated) case
8. Low Alarm adjustment (A5554)

Thermo Electric Part Numbers appear in parentheses. For additional components and part numbers refer to Section 7-0 Appendix, Front View.

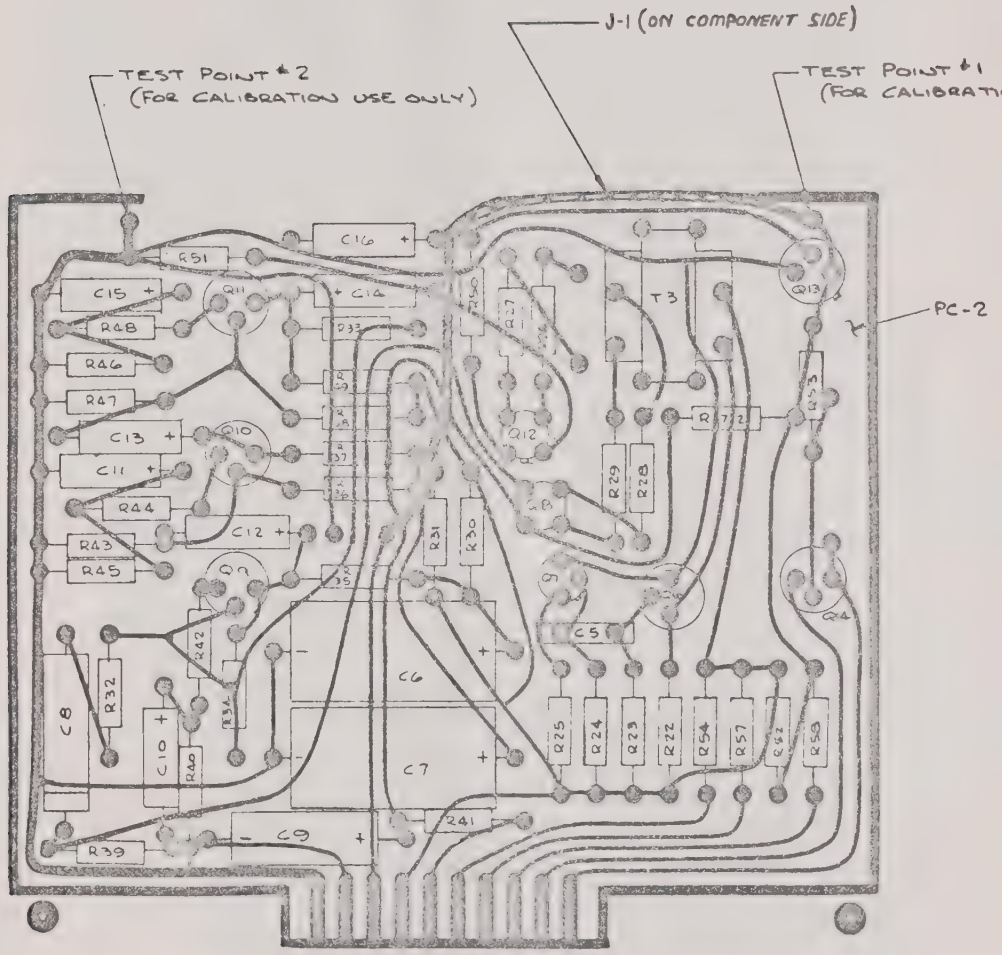
*Not used for 32411 Controllers

**For Models 32411-02 and 32411-03 use part number A6022-8
For Models 32411-04 and 32411-05 use part number A6021-7



PC-4	Printed circuit board (A5511)
Q25	Transistor 2N3566 (A4066) for A5512-1, 2N3568 (A4729) for A5512-2
Q26	Transistor 2N4249 (A4990)
Q27	Transistor 2N2647 (A5468)
Q28	Transistor 2N4249 (A4990)
Q29	Transistor 2N2647 (A5468)
Q30	Rectifier (SCR) C6B (A4447)
C20	Capacitor .1 mfd, 150 WVDC (A4443)
C21	Capacitor .1 mfd, 150 WVDC (A4443)
R1	Resistor 3.3 k ohm (7241-41)
R2	Resistor 3.3 k ohm (7241-41)
R3	Resistor 10 k ohm (7241-13)
R4	Resistor 18 k ohm (7241-39)
R5	Resistor 1 k ohm (7241-22)
R6	Resistor 680 ohm (7241-98) for A5512-1, 330 ohm (7241-122) for A5512-2
R7	Resistor 18 k ohm (7241-39)
R8	Resistor 1 k ohm (7241-22) for A5512-1, 2.7 k ohm (7241-42) for A5512-2
R9	Resistor 470 ohm (7241-27)
R10	Resistor 56 ohm (7241-91)
R11	Resistor 3.3 k ohm, 1 watt (7242-14)
R12	Resistor 1 k ohm (7241-22)
R13	Resistor 470 ohm (7241-27)
R14	Resistor 3.3 k ohm (7241-41)
R15	Resistor 3.3 k ohm (7241-41)
R16	Resistor 1 megohm (7241-6)
R17	Resistor 1 megohm (7241-6)
R18	Resistor 270 k ohm (7241-40) for A5512-2 only
R19	Resistor 3.3 k ohm (7241-41)

All resistors ± 10%, 1/2 watt unless otherwise specified.



PC-2	Amplifier board (A4893)
Q6	Transistor 2N3568 (A4729)
Q7	Transistor 5E35 (A4730)
Q8	Transistor 3N88 (A4731)
Q9	Transistor 2N3566 (A4066)
Q10	Transistor 2N3566 (A4066)
Q11	Transistor 2N3566 (A4066)
Q12	Transistor 3N88 (A4731)
Q13	Transistor 2N3638 (A4732)
Q14	Transistor 2N3566 (A4066)
T3	Transformer UTC-SO-16 (A4742)
	Bracket for above (A4745)
C5	.01 mfd capacitor, 25VDC (7902)
C6	100 mfd capacitor, 25VDC (A4737)
C7	100 mfd capacitor, 25VDC (A4737)
C8	.1 mfd capacitor, 150VDC (A4443)
C9	100 mfd capacitor, 10VDC (A5234)

C10 thru C16	15 mfd capacitor, 20 VDC (A5235)
R22	1.2 k ohm resistor (7241-62)
R23	33 k ohm resistor (7241-31)
R24	12 k ohm resistor (7241-54)
R25	470 ohm resistor (7241-70)
R26 thru R29	1.8 k ohm resistor ± 5% (7241-88)
R30	4.7 k ohm resistor (7241-24)
R31	1 k ohm resistor (7241-22)
R32	1 k ohm resistor (7241-22)
*R33	10 meg ohm resistor (7241-1) (omitted on A6169)
R34	33 k ohm resistor (7241-31)
R35	10 k ohm resistor (7241-13)
R36	12 k ohm resistor (7241-54)
R37	1.5 k ohm resistor (7241-25)
R38	4.7 k ohm resistor (7241-24)
R39	2.2 k ohm resistor (7241-21)
R40	2.2 k ohm resistor (7241-21)
R41	1 k ohm resistor (7241-22)
R42	22 ohm resistor (7241-87)
R43	4.7 k ohm resistor (7241-24)
R44	15 ohm resistor (7241-47)
R45	680 ohm resistor (7241-75)
R46	330 ohm resistor (7241-14)
R47	1.5 k ohm resistor (7241-25)
R48	15 ohm resistor (7241-47)
R49	820 ohm resistor (7241-81)
R50	430 ohm resistor (7241-71)
R51	1 k ohm resistor (7241-22)
R52	10 k ohm resistor (7241-13)
R53	4.7 k ohm resistor (7241-24)
R54	1.5 k ohm resistor (7241-25)
R57	1.8 k ohm resistor + 5% (7241-88)
*R58	10 k ohm resistor (7241-13)
R72	10 meg ohm resistor (7241-1)
J1	Jumper Wire

All resistors 1/2 watt, ± 10% unless otherwise specified.
Thermo Electric part numbers appear in parentheses.
*Value may vary. Refer to note on schematic diagram in Appendix.

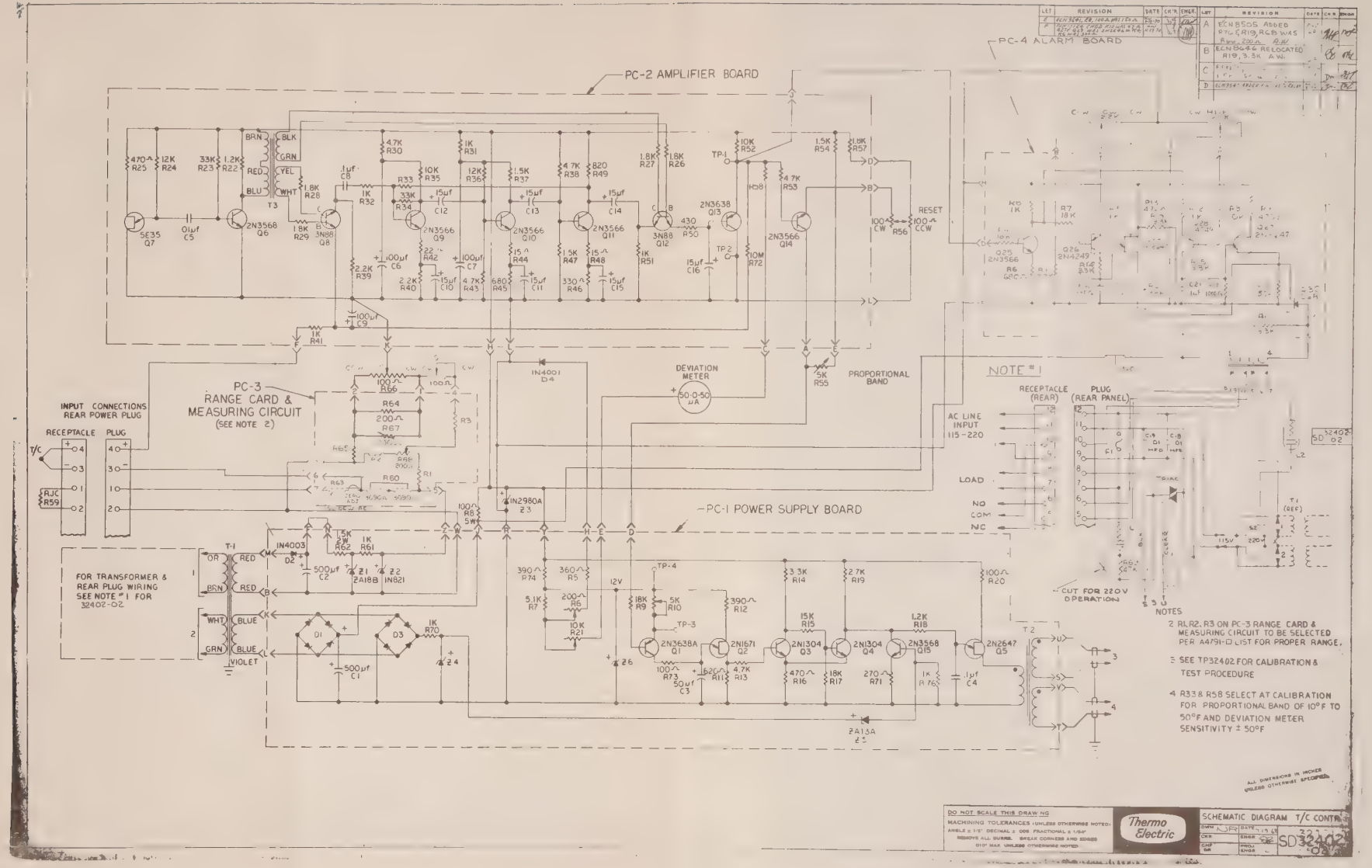
B. High Gain (For Models 32402-10 and 11)

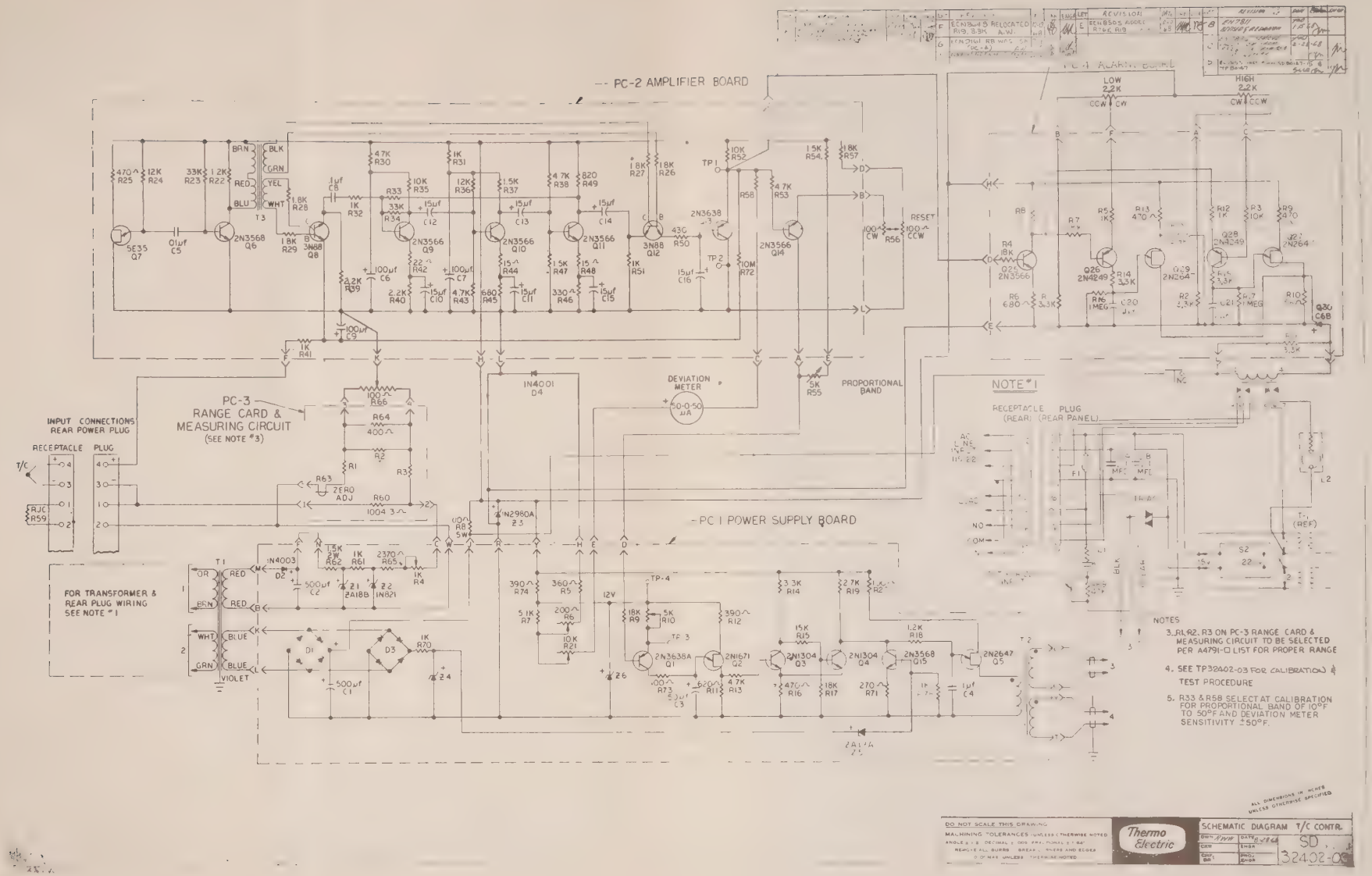
Controllers designated Model 32402-10 and 32402-11 have been modified to utilize temperature ranges below a 16 millivolt span using platinum alloy thermocouples and other low sensitivity thermocouples. These modifications include:

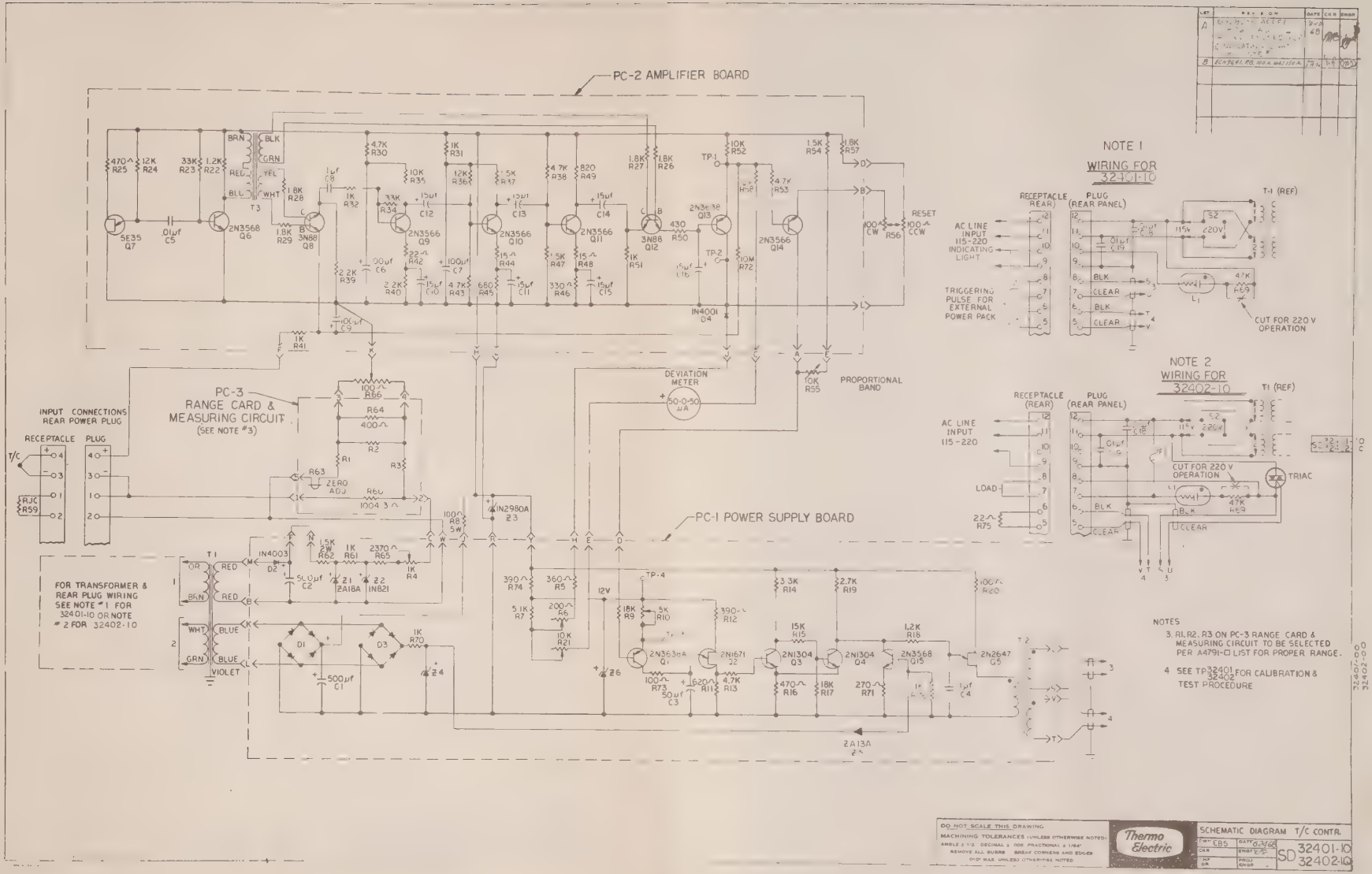
1. Removal of feed-back resistor R33 located on amplifier Printed Circuit Board 2. Printed circuit board assembly part number changed to A5550 for 32402-10 and A6169 for 32402-11.

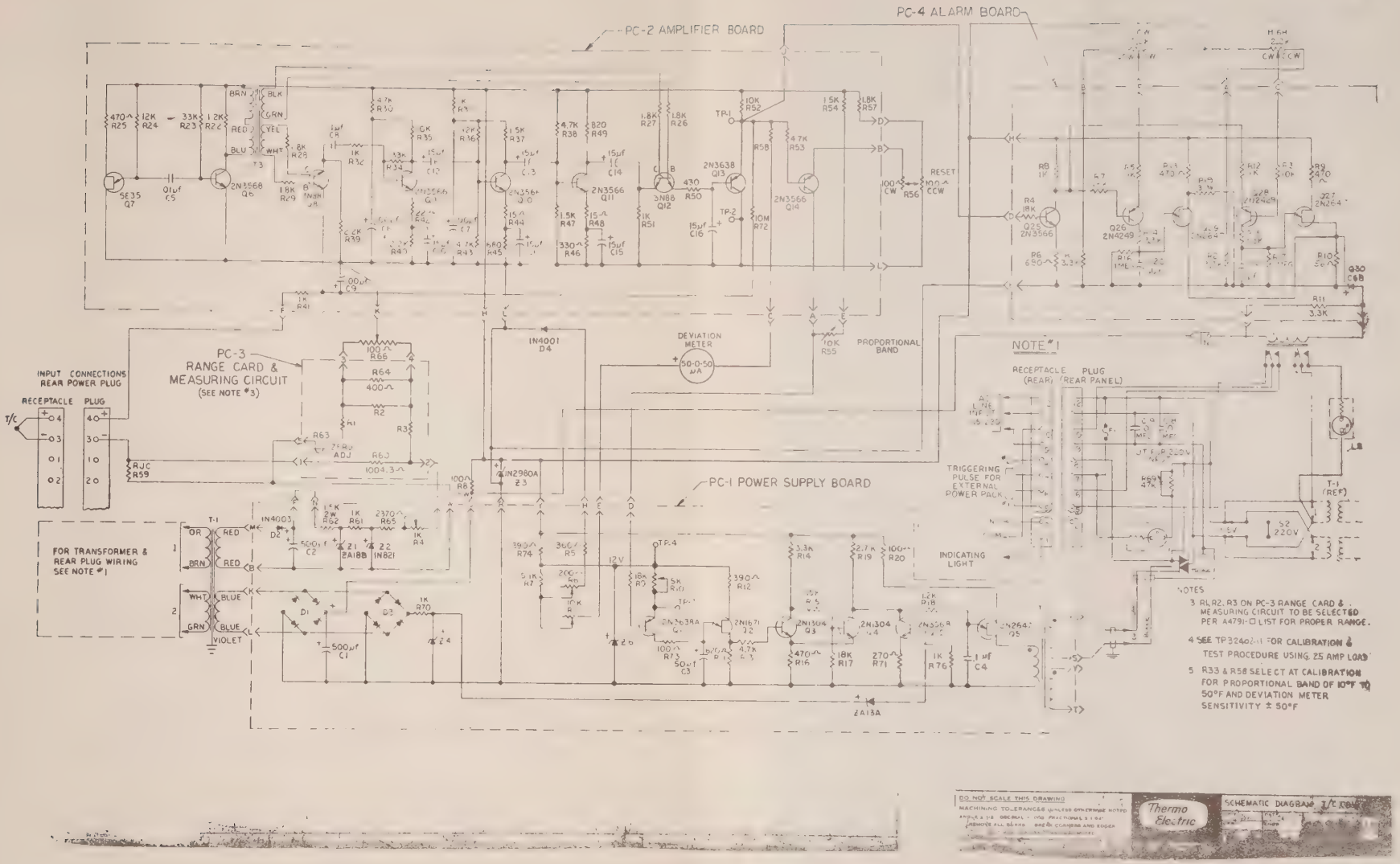
2. Proportional band potentiometer R55 increased from 5 k ohms to 10 k ohms. Thermo Electric part number A5549.

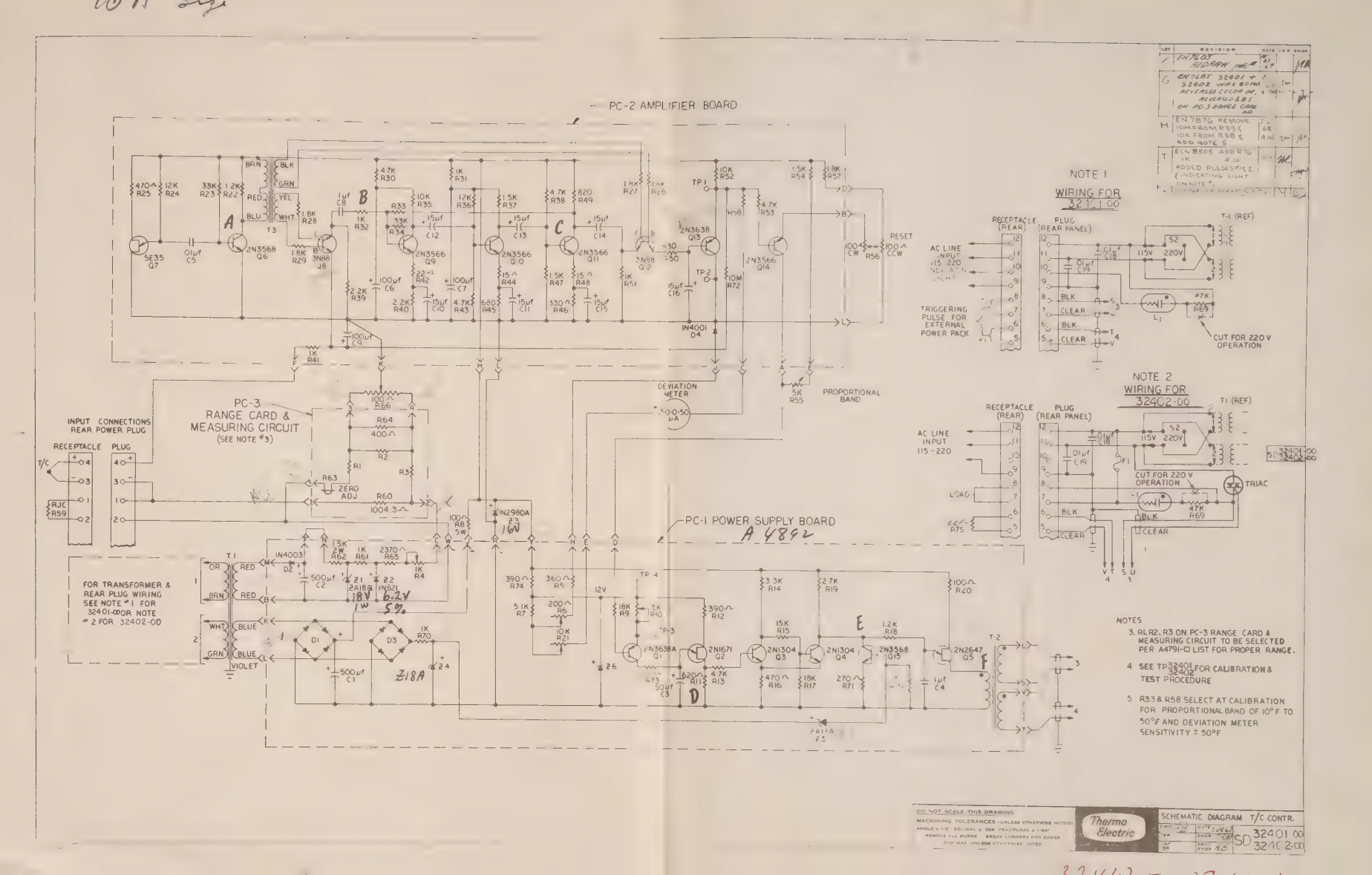
3. Indicating deviation meter scale increased from 50-0-50°F to 100-0-100°F (25-0-25°C to 50-0-50°C). Thermo Electric part number A4869-3 for Fahrenheit scale, A4869-4 for Centigrade scale.


PC-4 ALARM BOARD
PC-2 AMPLIFIER BOARD
PC-3
RANGE CARD &
MEASURING CIRCUIT
(SEE NOTE 2)
PC-1 POWER SUPPLY BOARD
INPUT CONNECTIONS
REAR POWER PLUG
RECEPTACLE
PLUG
T/C
RJC
R59
DEVIATION
METER
50-0-50
μA
PROPORTIONAL
BAND
5K
R55
RESET
100Ω CW
R56
100Ω CCW
TP-1
TP-2
TP-3
TP-4
2N3638
Q13
2N3566
Q14
2N3568
Q6
2N3566
Q9
2N3566
Q10
2N3566
Q11
3N88
Q12
5E35
Q7
3N88
Q8
T3
T-1
T2
IN4001
D4
IN2980A
Z3
IN4003
D2
IN821
Z2
2A18B
Z1
2A13A
Z5
2A24
Z4
2A26
Z6
D1
D3
2N3638A
Q1
2N1671
Q2
2N1304
Q3
2N1304
Q4
2N3568
Q15
2N2647
Q5
NOTE #1
RECEPTACLE
(REAR)
PLUG
(REAR PANEL)
AC LINE
INPUT
115-220
LOAD
NO
COM
NC
CUT FOR 220V
OPERATION
FOR TRANSFORMER &
REAR PLUG WIRING
SEE NOTE #1 FOR
32402-02
NOTES
2 RLR2, R3 ON PC-3 RANGE CARD & MEASURING CIRCUIT TO BE SELECTED PER A4791-D LIST FOR PROPER RANGE.
3 SEE TP32402 FOR CALIBRATION & TEST PROCEDURE
4 R33 & R58 SELECT AT CALIBRATION FOR PROPORTIONAL BAND OF 10°F TO 50°F AND DEVIATION METER SENSITIVITY ± 50°F
ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED
DO NOT SCALE THIS DRAWING
MACHINING TOLERANCES (UNLESS OTHERWISE NOTED)
Thermo Electric
SCHEMATIC DIAGRAM T/C CONTR
SD32402-02


-- PC-2 AMPLIFIER BOARD
PC-3
RANGE CARD &
MEASURING CIRCUIT
(SEE NOTE #3)
INPUT CONNECTIONS
REAR POWER PLUG
RECEPTACLE
PLUG
T/C
RJC
R59
FOR TRANSFORMER &
REAR PLUG WIRING
SEE NOTE #1
DEVIATION
METER
50-0-50
μA
PROPORTIONAL
BAND
5K
R55
RESET
100
R56
LOW
2.2K
HIGH
2.2K
- PC 1 POWER SUPPLY BOARD
NOTE #1
RECEPTACLE
(REAR)
PLUG
(REAR PANEL)
NOTES
3. R1, R2, R3 ON PC-3 RANGE CARD &
MEASURING CIRCUIT TO BE SELECTED
PER A4791-□ LIST FOR PROPER RANGE
4. SEE TP32402-03 FOR CALIBRATION &
TEST PROCEDURE
5. R33 & R58 SELECT AT CALIBRATION
FOR PROPORTIONAL BAND OF 10°F
TO 50°F AND DEVIATION METER
SENSITIVITY ±50°F.
DO NOT SCALE THIS DRAWING
Thermo
Electric
SCHEMATIC DIAGRAM T/C CONTR.
SD
32402-03


PC-2 AMPLIFIER BOARD
PC-3
RANGE CARD &
MEASURING CIRCUIT
(SEE NOTE #3)
PC-1 POWER SUPPLY BOARD
INPUT CONNECTIONS
REAR POWER PLUG
RECEPTACLE
PLUG
T/C
RJC
R59
DEVIATION
METER
50-0-50
μA
PROPORTIONAL
BAND
10K
R55
RESET
100Ω CW
R56
100Ω CCW
FOR TRANSFORMER &
REAR PLUG WIRING
SEE NOTE # 1 FOR
32401-10 OR NOTE
2 FOR 32402-10
ZERO
ADJ
R63
R60
100Ω
IN4003
IN2980A
Z3
IN4001
D4
Z1
2A18A
Z2
IN821
Z4
Z6
2A13A
Z5
D1
D2
D3
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
T1
T2
T3
TP1
TP2
TP3
TP4
Q1
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
Q13
Q14
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R21
R22
R23
R24
R25
R26
R27
R28
R29
R30
R31
R32
R34
R35
R36
R37
R38
R39
R40
R41
R42
R43
R44
R45
R46
R47
R48
R49
R50
R51
R52
R53
R54
R57
R64
R65
R66
R69
R70
R71
R72
R74
R75
1.5K 2W
R62
1K
R61
2370Ω
RED
BLU
BRN
BLK
GRN
YEL
WHT
VIOLET
OR
NOTE 1
WIRING FOR
32401-10
NOTE 2
WIRING FOR
32402-10
RECEPTACLE
(REAR)
PLUG
(REAR PANEL)
T1 (REF)
AC LINE
INPUT
115-220
INDICATING
LIGHT
TRIGGERING
PULSE FOR
EXTERNAL
POWER PACK
CUT FOR 220 V
OPERATION
LOAD
TRIAC
CLEAR
S2
115V
220V
L1
NOTES
3. R1, R2, R3 ON PC-3 RANGE CARD &
MEASURING CIRCUIT TO BE SELECTED
PER A4791-D LIST FOR PROPER RANGE.
4 SEE TP 32401
32402 FOR CALIBRATION &
TEST PROCEDURE
32401-00
32402-00
DO NOT SCALE THIS DRAWING
MACHINING TOLERANCES (UNLESS OTHERWISE NOTED)
ANGLE ± 1/2° DECIMAL ± .005 FRACTIONAL ± 1/64"
REMOVE ALL BURRS BREAK CORNERS AND EDGES
.010" MAX UNLESS OTHERWISE NOTED
Thermo Electric
SCHEMATIC DIAGRAM T/C CONTR.
SD 32401-10
32402-10


PC-2 AMPLIFIER BOARD
PC-4 ALARM BOARD
PC-3
RANGE CARD &
MEASURING CIRCUIT
(SEE NOTE #3)
INPUT CONNECTIONS
REAR POWER PLUG
RECEPTACLE
PLUG
T/C
RJC R59
PC-1 POWER SUPPLY BOARD
DEVIATION METER
50-0-50 μA
PROPORTIONAL BAND
10K R55
RESET
100 CW
100 CCW
R56
INDICATING LIGHT
TRIGGERING PULSE FOR EXTERNAL POWER PACK
RECEPTACLE (REAR)
PLUG (REAR PANEL)
FOR TRANSFORMER & REAR PLUG WIRING SEE NOTE #1
VIOLET
NOTE #1
NOTES
3 RL R2, R3 ON PC-3 RANGE CARD & MEASURING CIRCUIT TO BE SELECTED PER A4791-□ LIST FOR PROPER RANGE.
4 SEE TP 3240Z-11 FOR CALIBRATION & TEST PROCEDURE USING 25 AMP LOAD
5 R33 & R58 SELECT AT CALIBRATION FOR PROPORTIONAL BAND OF 10°F TO 50°F AND DEVIATION METER SENSITIVITY ± 50°F
DO NOT SCALE THIS DRAWING
Thermo Electric
SCHEMATIC DIAGRAM T/C KOMP


PC-2 AMPLIFIER BOARD
PC-3 RANGE CARD & MEASURING CIRCUIT (SEE NOTE #3)
INPUT CONNECTIONS REAR POWER PLUG
RECEPTACLE
PLUG
T/C
RJC R59
FOR TRANSFORMER & REAR PLUG WIRING SEE NOTE #1 FOR 32401-00 OR NOTE #2 FOR 32402-00
PC-1 POWER SUPPLY BOARD A 4892
DEVIATION METER
500-0-500 μA
PROPORTIONAL BAND
5K R55
RESET
100 CW R56
100 CCW
TP1
TP2
TP3
TP4
ZERO ADJ
R63
R60 1004.3Ω
R64 400Ω
R66 100Ω
R1
R2
R3
R4
R8 5W
R5
R6
R7
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R21
R25
R24
R23
R22
R26
R27
R28
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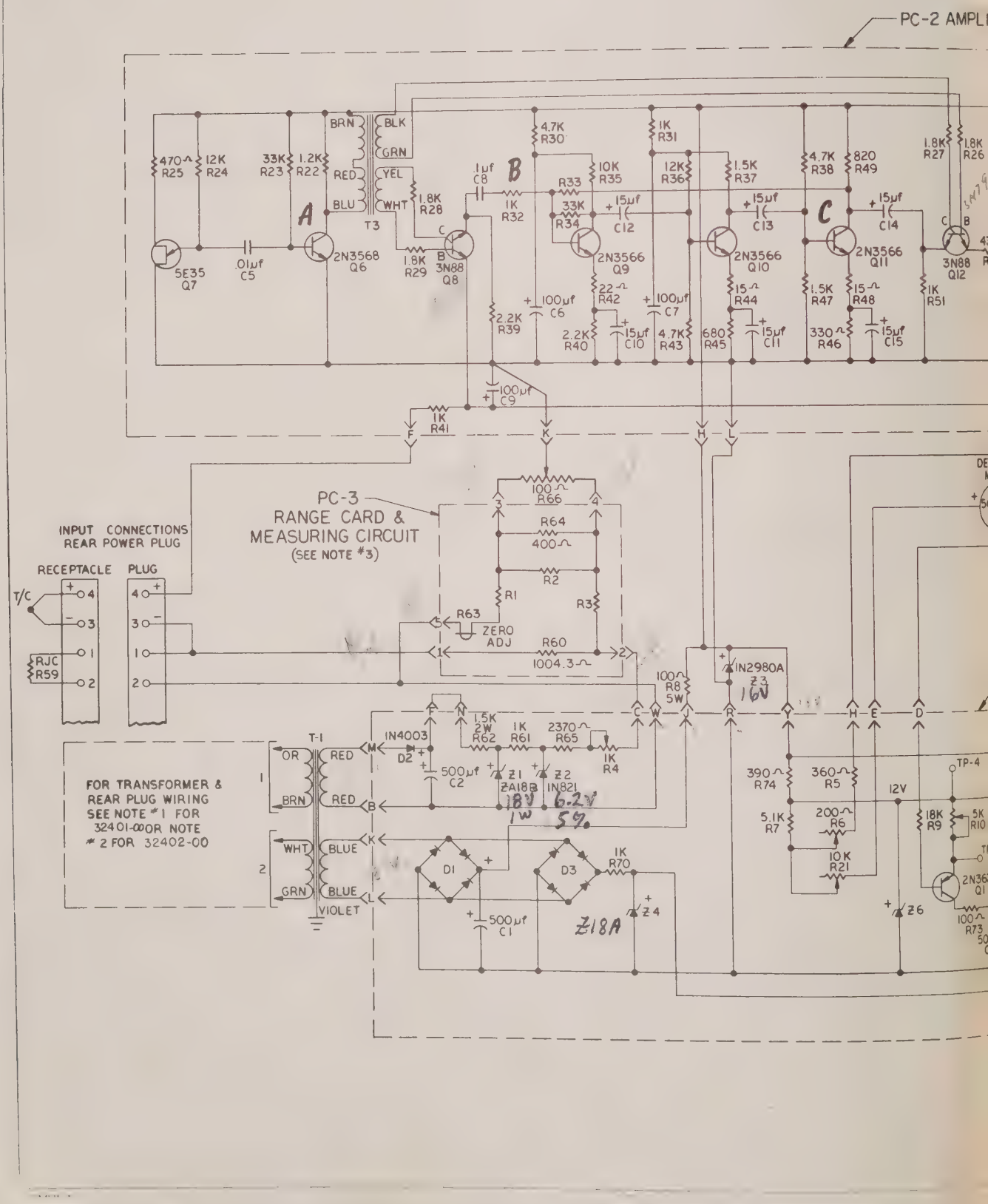
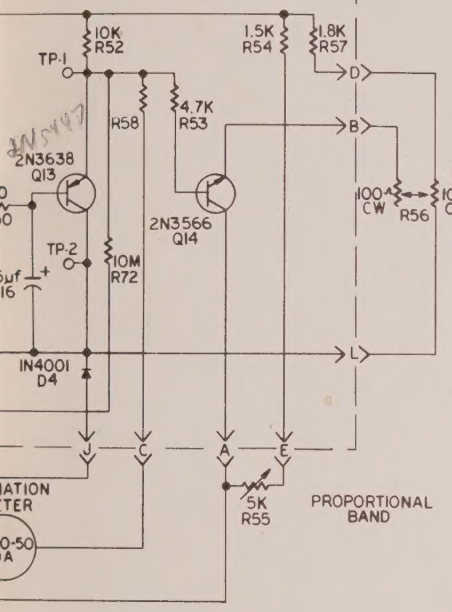
R47
R48
R49
R50
R51
R52
R53
R54
R57
R61
R62
R65
R70
R72
R73
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
D1
D2
D3
D4
IN4003
IN2980A 23 1W
2A18B 18V 1W 5%
IN821 6.2V
Z18A
Z24
Z1
Z2
Q1 2N3638A
Q2 2N1671
Q3 2N1304
Q4 2N1304
Q5 2N2647
Q6 2N3568
Q7 SE35
Q8 3N88
Q9 2N3566
Q10 2N3566
Q11 2N3566
Q12 3N88
Q13 2N3638
Q14 2N3566
Q15 2N3568
T1
T2
T3
BRN
BLK
GRN
YEL
WHT
RED
BLU
OR
BRN
RED
WHT
BLUE
GRN
BLUE
VIOLET
A
B
C
D
E
F
NOTE 1
WIRING FOR 32401-00
RECEPTACLE (REAR)
PLUG (REAR PANEL)
T-1 (REF)
AC LINE INPUT 115-220
TRIGGERING PULSE FOR EXTERNAL POWER PACK
115V
220V
S2
CUT FOR 220 V OPERATION
NOTE 2
WIRING FOR 32402-00
LOAD
TRIAC
FI
NOTES
3. R1, R2, R3 ON PC-3 RANGE CARD & MEASURING CIRCUIT TO BE SELECTED PER A4791-D LIST FOR PROPER RANGE.
4. SEE TP 32401 FOR CALIBRATION & TEST PROCEDURE
5. R33 & R58 SELECT AT CALIBRATION FOR PROPORTIONAL BAND OF 10°F TO 50°F AND DEVIATION METER SENSITIVITY ± 50°F
DO NOT SCALE THIS DRAWING
MACHINING TOLERANCES UNLESS OTHERWISE NOTED
Thermo Electric
SCHEMATIC DIAGRAM T/C CONTR.
SD 32401-00 32402-00

To A Size


PC-2 AMPL
470Ω R25
12K R24
33K R23
1.2K R22
BRN
BLK
GRN
RED
YEL
WHT
BLU
T3
1.8K R28
.1µf C8
4.7K R30
1K R31
1.8K R27
1.8K R26
A
B
C
10K R35
12K R36
1.5K R37
4.7K R38
820 R49
1K R32
R33
33K R34
+15µf C12
+15µf C13
+15µf C14
5E35 Q7
.01µf C5
2N3568 Q6
1.8K R29
3N88 Q8
2N3566 Q9
2N3566 Q10
2N3566 Q11
3N88 Q12
22Ω R42
15Ω R44
1.5K R47
15Ω R48
1K R51
+100µf C6
+100µf C7
2.2K R39
2.2K R40
+15µf C10
4.7K R43
680 R45
+15µf C11
330Ω R46
+15µf C15
+100µf C9
1K R41
F
K
H
L
PC-3
RANGE CARD &
MEASURING CIRCUIT
(SEE NOTE #3)
100Ω R66
R64
400Ω
R2
R1
R3
R63
ZERO ADJ
R60
1004.3Ω
INPUT CONNECTIONS
REAR POWER PLUG
RECEPTACLE
PLUG
T/C
RJC R59
100Ω R8 5W
IN2980A Z3 16V
1.5K 2W R62
1K R61
2370Ω R65
1K R4
IN4003 D2
500µf C2
Z1 ZA18B 18V 1W
Z2 IN821 6.2V 5%
T-1
FOR TRANSFORMER & REAR PLUG WIRING SEE NOTE #1 FOR 32401-00 OR NOTE #2 FOR 32402-00
OR
RED
BRN
WHT
BLUE
GRN
VIOLET
D1
D3
1K R70
500µf C1
Z18A
Z4
390Ω R74
360Ω R5
5.1K R7
200Ω R6
10K R21
12V
Z6
TP-4
18K R9
5K R10
100Ω R73
2N36 Q1

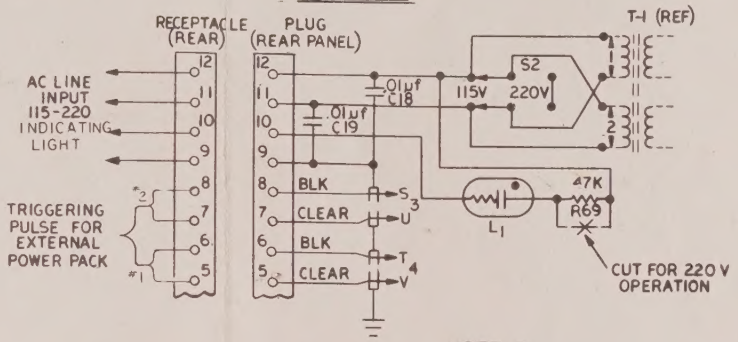
LET.	REVISION	DATE	CK'R.	ENGR.
F	EN7603 REDRAW AND ADD NOTE 5	8-23-67		
G	EN7685 32401 + 32402 WAS 80140 REVERSED COLOR OF, & REVERSED 4 & 5 ON PC-3 RANGE CARD AR	9-5-67		& BRN ON T1
H	EN 7876 REMOVE 10M FROM R33 & 10K FROM R58 & ADD NOTE 5	2-27-68	A.W.	
J	ECN 8505 ADD R76 1K A.W. ADDED PULSES #1 & 2 & INDICATING LIGHT ON NOTE #1	10-10-68		
K	ECN 9641, R8, 100Ω WAS 150Ω	5-10-71		

FIER BOARD



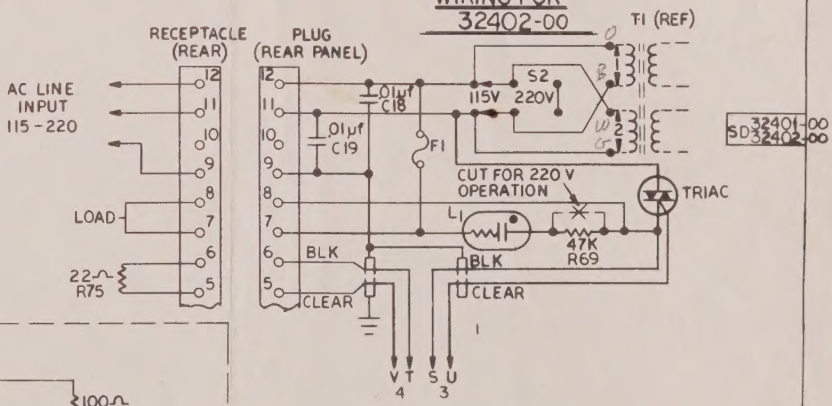
NOTE 1

WIRING FOR 32401-00



NOTE 2

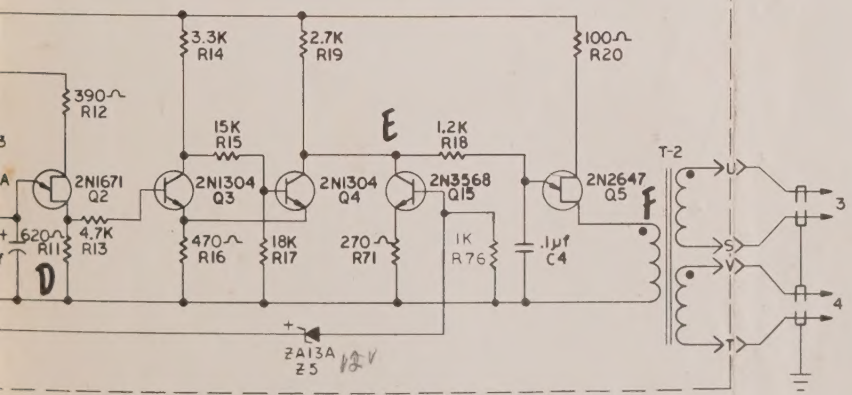
WIRING FOR 32402-00



SD 32401-00 32402-00

PC-1 POWER SUPPLY BOARD

A 4892



NOTES

3. R1, R2, R3 ON PC-3 RANGE CARD & MEASURING CIRCUIT TO BE SELECTED PER A4791-□ LIST FOR PROPER RANGE.
4. SEE TP 32401 / 32402 FOR CALIBRATION & TEST PROCEDURE
5. R33 & R58 SELECT AT CALIBRATION FOR PROPORTIONAL BAND OF 10°F TO 50°F AND DEVIATION METER SENSITIVITY ± 50°F

DO NOT SCALE THIS DRAWING

MACHINING TOLERANCES (UNLESS OTHERWISE NOTED) ANGLE ± 1/2°, DECIMAL ± .005, FRACTIONAL ± 1/64" REMOVE ALL BURRS. BREAK CORNERS AND EDGES .010" MAX. UNLESS OTHERWISE NOTED.

Thermo Electric

SCHEMATIC DIAGRAM T/C CONTR.

DWN. DATE 5-24-67
CKR. ENGR. J.T.M.
CHF. DR. PROJ. ENGR. R.B.

SD 32401-00 32402-00

32402- 32401-

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